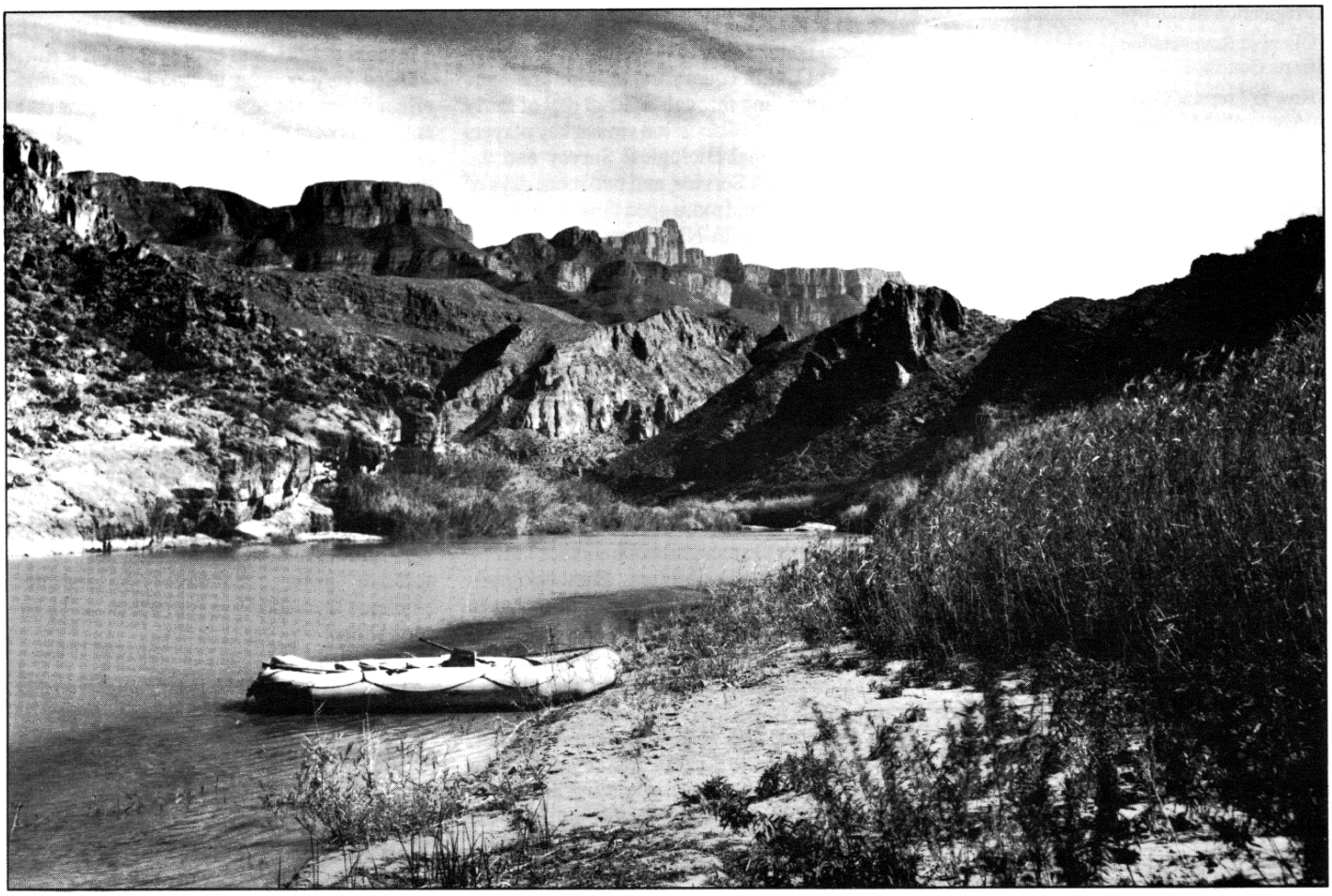
PARK SCIENCE

A Resource Management Bulletin

Volume 14 — Number 2 National Park Service U.S. Department of the Interior Spring 1994

User Study Contributes to Rio Grande Management

By W. P. Stewart, K. A. Yarborough, and J.R. Skiles



Raft in Boquillas Canyon, Big Bend NP. This river section is also part of the Rio Grande Wild and Scenic River. El Pico, of the Sierra Del Carmens, is the prominent peak in the background.

A recently completed user study of the Rio Grande in Big Bend NP, undertaken in pursuit of a river use management plan, comprised four areas of investigation associated with river users:

(1) a trend study of 16,500 river permits that documented river use from 1983 through 1992;

(2) a survey of boaters who obtained private river use permits;

(3) a survey of visitors who obtained overnight backcountry permits to camp at designated sites adjacent to the river, and

(4) a survey of patrons of commercial outfitters associated with float trips on the Rio Grande.

The forthcoming River Use Management Plan (RUMP) will be the first of its kind for the Rio Grande River in Big Bend NP. Big Bend's regulations pertaining to river operations heretofore have been contained in other types of management plans. The RUMP is being developed as a response to specific questions regarding river management objectives and use procedures.

It also is being designed to provide standard operational information to patrol rangers, resource management, and visitor contact staff. In addition to the user study, an ongoing study regarding recreation and trespass-livestock impacts to the riparian ecosystem will provide research-based information to the developing RUMP.

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PARK SCIENCE

NATIONAL PARK SERVICE

SPRING 1994

A report to park managers of recent and on-going research in parks with emphasis on its implications for planning and management.

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DEPARTMENTS

Editorial

Yo, field troops! A dispatch from the front.

Having heard, felt, even experienced some of the angst that currently is rocking the National Park Service field personnel, I can report that I approached the March 1-3 Regional Chief Scientists meeting in Washington, D.C. with equal parts of hope and fear.

After sitting through one full day of fairly frank and open discussion among key players in the National Biological Survey and the National Park Service, and two more days of even franker and more open thrashing over of the situation with NPS personnel only, my assessment is as follows:

The NBS is currently a non-negotiable fact of Department of the Interior life. The Secretary and the Director stand solidly behind its organization and implementation. The two most powerful players in its make-up—the U.S. Fish and Wildlife Service and the National Park Service—are doing their level best to make it work.

I saw good people from two very different science programs striving with good will and commitment to recognize one another's viewpoints and responsibilities. They acknowledged the difficulties they face in trying to meld their different skills and resources, and they gave evidence of being willing to tackle what must eventually become their **mutual** problems.

Promises and pitfalls are a natural coupling that occurs at all major crossroads; jitters are natural and understandable. Into the swirl of events that constitute "present conditions" must go not just the best-laid plans of the well intentioned, but also the human climate such conditions engender. The human perception today seems to range from supreme confidence, downhill through educated doubts, and ending in stark terror.

Also very present is "the butterfly wing effect." Given the extremely fluid state of the emerging new order, the softest bump from anywhere could tip the balance of direction. Frantic phone calls from the field during the March RCS meeting in D.C. emphasized the wisdom of keeping field personnel fully advised as to developments. Well meaning people are attempting to shape an approach that will be stronger, better armed, and more responsive to park management needs. The very real fears of resource managers need to be recognized, honored, and dealt with openly.

To pull off what is being attempted here would be a monumental task even in the best of all possible circumstances. To do so in straitened fiscal times is even more challenging. Small factors can have huge effects at times of "initial conditions." So grab the moment all you positive butterflies, and beat your wings!

Editor's Note: For additional thoughts on this philosophy, please refer to Book Review (page27), especially the portion dealing with Leadership and the New Science *by Margaret J. Wheatley on page 28.*

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Recreational Access

The Rio Grande is unusual among western rivers in that it can be accessed at several points along its course. Within Big Bend NP, a 118-mile stretch of the Rio Grande forms the international boundary with Mexico and cuts through three deep, steep-walled, limestone canyons: 8 miles in Santa Elena, 6 miles in Mariscal, and 32 miles in Boquillas. Two non-canyon river segments are: (1) between Santa Elena and Mariscal, referred to as the Rio Vista segment; and (2) between Mariscal and Boquillas, referred to as the San Vicente segment. Paved and unpaved roads provide several opportunities to access, launch-on, and take-out from these 5 segments of the river.

Results of the Trend Study

Of the 10 examined years, 1985 was the peak year for use. Approximately twice as many permits were issue in 1985 as for 1989, 1990, or 1991. A general drop in total number of permits since 1985 appears to be attributable to a drop in the number of *private* (compared to commercial) permits issued. (The proportion of private to commercial use permits in 1992 was about 50/50.)

Over the past 10 years, less than 4 percent of the permits issued were for more than one river segment. In other words, most users travel one canyon or segment at a time. The trend study indicates that the historic use patterns are different for each river segment. Santa Elena has been the most popular canyon to float, and is associated with four times the number of annual permits issued for any of the other four river segments.

In addition, day-use permits for Santa Elena increased dramatically in the mid-1980s and since have leveled off, whereas overnight permits for Santa Elena have decreased since the mid-1980s. Commercial use is primarily focused on Santa Elena Canyon. More than 85 percent of 1992 commercial permits were issued for Santa Elena, whereas private use in 1992 was spread evenly among the Santa Elena, Boquillas, and San Vicente segments. Private use levels in Mariscal Canyon, which is accessed primarily by unpaved or primitive roads, is about one-third the private use levels of the other river segments (most likely due to its remote access points).

Results of the Visitor Surveys

The social setting varied across the five river segments. Santa Elena Canyon was the segment associated with the most reported contacts with other rafters: 56 percent of Santa Elena private-permittee respondents indicated seeing more than 10 non-motorized rafts. Bouquillas was second in terms of contacts with other rafts, with 41 percent of private-permittees indicating they saw more than 10 rafts. Mariscal segment was associated with the least number of raft contacts; just 9 percent of private-permittees reported greater than 10 raft encounters.

The importance of solitude and being alone varied across respondents from the different river segments. Boquillas floaters were most likely to report solitude as extremely important; Santa Elena floaters were least likely to report solitude as extremely important.

The importance of fishing also varied across the river segments. Rio Vista and San Vicente permittees were more than twice as likely to fish as Mariscal floaters, and they were more than five times as likely to fish as either Boquillas or Santa Elena floaters.

The type of trip planning varied, with Rio Vista and San Vicente floaters indicating the least amount of advance planning for their trips and the most flexibility regarding the whereabouts of their river recreational experience.

Trespass livestock (mainly equine) has been a longstanding problem along the Rio Grande corridor of the park. The user study provided information as to the social impacts of trespass livestock. The apparentness of livestock impacts (e.g., trampling, grazing, and manure) varied across the river segments. Rio Vista and San Vicente permittees were least likely to perceive evidence of livestock; Boquillas permittees were most likely to note such evidence.

The perception of livestock impact varied by season, with fall floaters noting the most impact compared to either spring or summer floaters. These social impacts correspond with a seasonal "recovery" period noted in the study of impacts on biota. Summer rains renew the grasses and "sweep" clean the river corridor. In fall and winter, the corridor is less resilient, due to the absence of rains and subsequent renewed vegetative growth.

Management Recommendations

The primary recommendation from the user study is to maintain and explicitly develop the diversity of recreation opportunities afforded by the Rio Grande.

Maintaining diversity of recreation experiences entails recognizing the variety of river recreation opportunities associated with each segment of the river and establishing distinct management strategies for each segment. The results of research indicate that the recreation experience differs across the various river segments, that use levels have differed historically across the segments, and that users recognize differences across the river segments.

In the past, management operations implicitly have facilitated the provision of differing opportunities. Providing for the long-run continuation of such diversity is an important directive for Rio Grande management. Compared to other western rivers, recreational use of the Rio Grande in the park is not considered too high; however, recommendations are offered in preparation for changing (increasing) use levels in the future, should such occur. They are:

a) Consider adopting a river permit process that allows for managerial control of private permittee use levels;

b) Consider an advanced reservation system for river use permits;

c) Insure that staff members issuing river use permits have field knowledge of the sites and conditions of the Rio Grande;

d) Continue to work with Mexican authorities to direct the coordination of river management; and

e) Insure the periodic clean-up of litter in the river corridor.

Development of the River Use Management Plan

A team has been developing the RUMP since June 1993 and the plan is scheduled for completion by fall 1994. Information from social and ecology-based research, commercial use licensees, private user groups, and Mexican authorities will contribute to its development. Following an in-house review, the first draft of the RUMP will be distributed for public comment by mid-1994. Workshops will be held to encourage public comments; information obtained from these workshops will be considered for incorporation into the plan.

For further information on the RUMP process contact Yarborough or Skiles, both at Big Bend NP, TX 79834; (915) 477-2251. For a copy of the user study technical report contact Stewart at College Station, TX 77843-2261.

Stewart is an Associate Professor at Texas A&M University, College Station, TX; Yarborough is Park Scientist and Skiles is a Wildlife Resource Management Specialist, both at Big Bend NP.

Abandoned Road Restoration Methods Tested at Grand Tetons National Park

By Edward Redente, Nicholas Cotts, and Robert Schiller

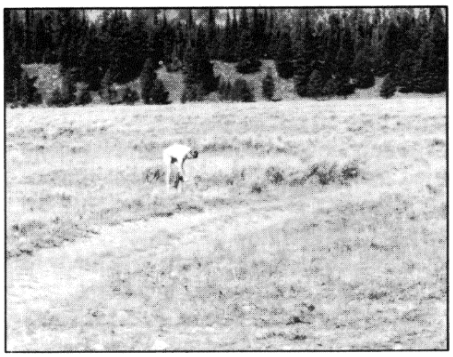
Every park, monument, and historic site within the National Park System has some disturbance that can be associated with either past or present anthropogenic activities. These disturbances alter both the structure and function of ecosystems and may result in landscape features that are aesthetically unacceptable. Disturbed areas also become ideal locations for establishment and spread of exotic plants and noxious weeds.

Restoration is the process of intentionally altering a site to establish a defined, indigenous, historic ecosystem. The goal is to emulate the structure, function, diversity, and dynamics of the specified ecosystem. Reclamation, on the other hand, has been defined historically as the process of returning disturbed land to a condition that approximates the original site conditions and is habitable by the same or similar plants and animals as existed on the site before disturbance.

Reclamation typically involves the restoration of certain processes or functions, but typically stops well short of restoration. It may however be viewed as an important step toward restoration. Restoration will be successful only if we (1) adequately understand how the disturbed system functions and what the limiting factors are, and (2) develop and apply the correct prescriptions. The restoration process is not simple and in most cases requires enough time to allow natural biological process, such as succession, to occur.

The NPS can use restoration techniques to treat disturbed sites so as to control erosion, remove exotic and noxious plant species, increase biodiversity of indigenous species, reestablish nutrient cycles, and improve aesthetic values. This report summarizes results from a research project designed to test the effectiveness of different restoration techniques on an abandoned road in Grand Teton NP. The specific objectives of this project were (1) to evaluate the effectiveness of various levels of site manipulation such as seeding, fertilizing, scarifying, topsoiling, and mulching, and (2) to compare the performance of seed from native species collected within the park to seed from native species obtained from commercial sources.

This research was part of a larger road construction project that included a seed collection and increase program in association with the Soil Conservation Service. Seed that was collected in Grand Teton was increased by the Environmental Plant Center in Meeker, CO, for restoration work in the park.



Test plot construction in the fall of 1988.

Abandoned road site at the north end of Timbered Island in Grand Teton NP. Seed in the area was collected to compare the effectiveness of indigenous seed vs. commercial seed.

The Study Site

The study was conducted within the disturbed tracks of an abandoned road at a 2,075 m elevation. Climate there is semiarid, with hot, dry summers and cool, wet winters. Average annual precipitation is 68 cm, with a mean annual temperature of 2.2 C. The soils of the area were formed on stream terraces and alluvial fans as well as glacial outwash materials from the Teton range. The soils are characterized as well drained, with moderate permeabilities.

The undisturbed community surrounding the study site can be classified as a low sagebrush/big sagebrush mosaic. The disturbed, abandoned road site consisted of highly compacted soils, low organic matter and nutrient levels, and absence of vegetation.

Methods

The study was begun in the fall of 1988. Over a four year period, 14 treatments were tested. A detailed description of them can be found in Cotts et al. (1991). Plant cover was measured by species during the growing seasons of 1989 through 1992. In addition, woody plant density was determined during the same time period and aboveground production was estimated, using a direct harvest method in 1992.

Infiltration and bulk density tests were conducted on scarified/non-scarified treatments and topsoiled/non-topsoiled treatments to assess the effect of soil scarifying and topsoiling on infiltration and bulk density. Aggregate stability analyses also were completed on the same treatments following the procedures of Kemper and Rosenau (1986) to understand the relationship between bulk density, infiltration, and aggregate size and stability of the treated and untreated soils on the site.

Results and Discussion

After four growing seasons we found that the topsoiled treatments supported the most plant cover and biomass, with 5 cm of topsoil providing more favorable results than 15 cm of topsoil (Fig. 1). Topsoil treatments that were seeded (to either indigenous or commercial seed) were dominated by perennial grasses, while non-seeded topsoil treatments were dominated by big sagebrush—the dominant species in the surrounding plant community.

Non-topsoil treatments had significantly less plant cover and biomass than topsoiled treatments, but those treatments that were seeded to the indigenous mixture showed good plant community development. Scarifying the original road substrate yielded better plant growth than non-scarifying, and mulching produced no differences in plant cover or production.

Infiltration and bulk density analyses were conducted to determine if compaction was a problem and if the selected treatments of scarifying and topsoiling improved the physical parameters of the road substrate. The undisturbed soil surrounding the road had the lowest bulk density, while the non-scarified road surface had the highest bulk density, confirming that the road had been compacted as a result of many years of vehicular activity.

It was expected the infiltration rates would be inversely correlated with bulk density; in other words, as bulk density increased, infiltration would decrease. The results of our testing showed that scarifying the road substrate reduced bulk density, but infiltration rates were not improved. Additional analyses of aggregate stability showed that the compacted soil from the road substrate had smaller and less stable aggregates than either the undisturbed soil or the topsoil used in the study.

We found that these less stable aggregates would disintegrate upon wetting, thus plugging macropores in the soil and reducing infiltration. It must therefore be recognized that although scarifying soil may reduce bulk

density and create more favorable seedbed characteristics, it may not improve infiltration if an aggregate stability problem exists. Aggregate stability will only improve with the addition of organic matter and after other soil building processes occur, such as soil microbial development.

Implications

Our research has shown that disturbances such as abandoned roads can be restored successfully with a variety of approaches that vary in the level of resource inputs and also in time required for complete restoration to occur. The applications of small amounts of topsoil (as little as 5 cm) in combination with seeding of indigenous seed will produce a plant community that will emulate the surrounding undisturbed community in as little as 15 years in environments similar to that at our Grand Teton study site.

We believe, however, that less intensive approaches, such as soil scarification in combination with seeding indigenous species, will result in successful restoration in a time frame of 20 to 25 years. Since indigenous seed performed better than native seed obtained commercially, we recommend that restoration projects use seed from sources known to be adapted to the climate and soil characteristics of the area to be restored.

With respect to economic considerations, the cost associated with adding 5 cm of topsoil and seeding indigenous plant materials would be approximately $5,000/ha ($2,100/ac). These costs are based on estimates associated with restoration work in the Grand Tetons and will vary depending on site conditions, sources of topsoil, and distance required to transport soil.

Restoration is a long-term process that is dependent upon natural physical and biological processes to bring it to completion. It is therefore critical that patience be seen as a necessary virtue for all resource managers involved in such projects. Also, it should be understood that limited resource inputs can prove to be valuable approaches where the time frame for success is not a major restriction.

Redente is a professor in the RangelandEcosystem Science Dept., CO/State/U, Fort Collins; Cotts previously was a graduate student at Colorado State and currently is a reclamation specialist with Shepherd Miller, Inc., of Fort Collins; Schiller is Chief, Branch of Science in the NPS Denver Regional Office.

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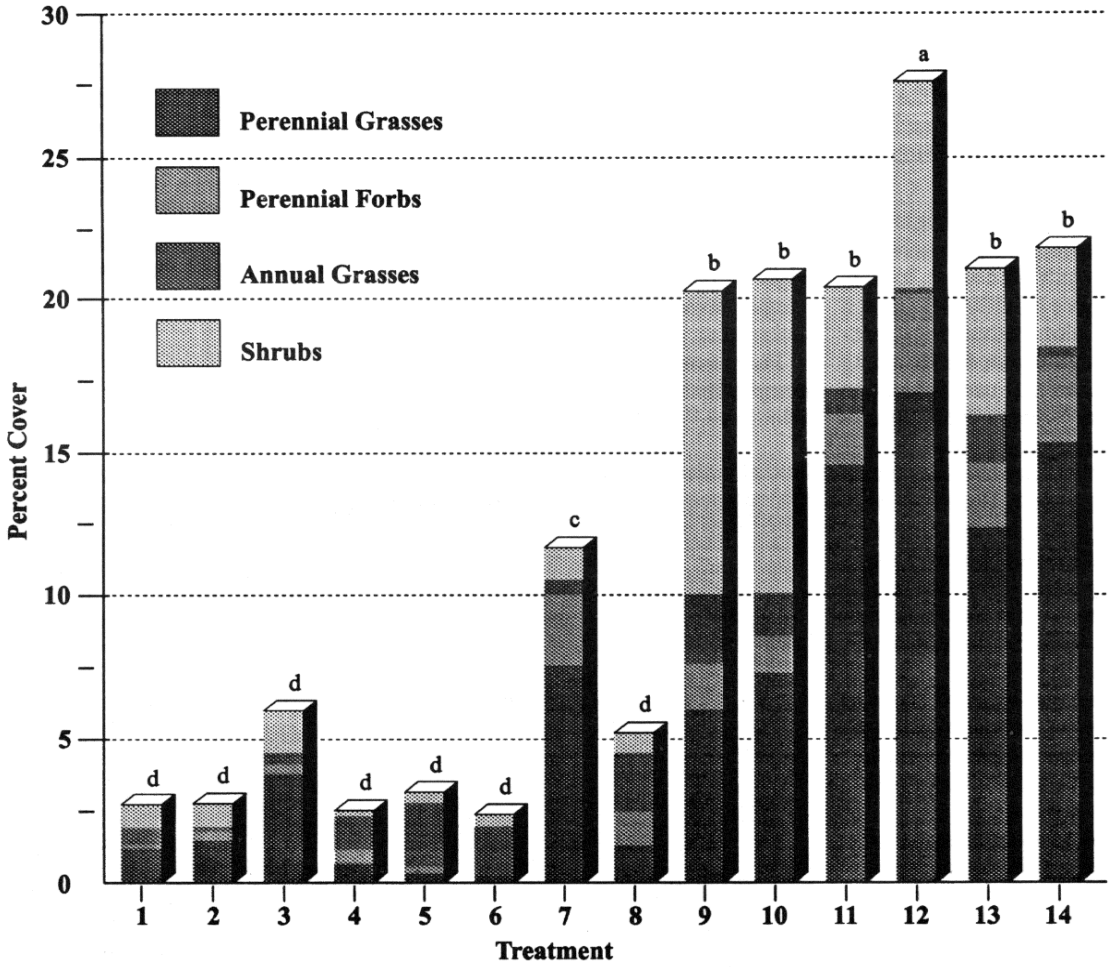
Figure 1. Total plant cover in 1992, four years following initial treatment. Treatments with the same letter are not significantly different at P<0.05.



1. Control
2. Control and Mulch
3. Indigenous Seed
4. Commercial Seed
5. Scarify, No Seed
6. Scarify, Rock Raking
7. Scarify, Indigenous Seed
8. Scarify, Commercial Seed
9. 15 cm Topsoil and Scarify
10. 15 cm Topsoil, Scarify, Fertilize
11. 15 cm Topsoil, Scarify, Indigenous Seed
12. 5 cm Topsoil, Scarify, Indigenous Seed
13. 15 cm Topsoil, Scarify, Commercial Seed
14. 15 cm Topsoil, Scarify, Indigenous Seed, Mulch

Glacier NP Undertakes Revegetation Monitoring

By Kristin Vanderbilt

Visitor impacts, facility maintenance, and road reconstruction in Glacier National Park present a continuously recurring problem of disturbed lands and the need for effective revegetation procedures. While roadcuts covered with native grasses and forbs point to some of Glacier's successes, areas of high exotic species density or bare slopes suggest that revegetation treatments were inadequate, or that it may be impossible to re-establish a native community on all disturbed sites.

In 1992, Glacier NP began a monitoring program to record the status of revegetated sites in order to evaluate possible sources of failure. Monitors describe target plant communities for project locations, against which overall revegetation success may be measured. Program objectives are to improve the methods and learn the limits of what revegetation can accomplish, so that realistic restoration goals may be established.

The monitoring program includes (1) a pre-disturbance visit to describe the site and establish goals in terms of a reasonable target community, and (2) periodic monitoring of revegetated areas to judge how well the seeded and planted species are faring and how satisfactorily long-term goals are being met.

Site Analysis

Effective revegetation efforts begin with thorough site evaluations. The monitoring program's Site Analysis procedure, loosely based on Forest Service ECODATA (Jensen et al, 1992) ocular plot methodology, provides a systematic framework for recording soils, microclimate, animal use, vegetation structure, and species canopy cover information relevant to revegetation needs.

Data on these characteristics are taken from a representative plot. Based on what vegetation is on the site, what grows nearby, and the management plan for the area, a target community is suggested. For example, a deleted roadside turnout in a lodgepole forest, which will be mowed yearly, may be targeted for the understory lodgepole low shrub and herbaceous community. Two site analyses frequently are conducted, one to describe the disturbed site to be revegetated, the other to describe an undisturbed plot that represents the target community.

Once goals for the area have been set, the site analysis involves making recommendations for plant material use, fertilizer application, mulch, plant salvage, and soil salvage. The site analysis procedure is structured to record current site and plant community conditions, set revegetation goals, and guide efforts to meet those goals.

Various staff members who conducted site analyses during the summer of 1993 have found this a valuable planning tool. The detailed record of species and their abundance in the target community is useful when seed mixes are prepared and nursery stock needs estimated. Soils and microsite information may suggest special planting and watering requirements, which are figured in during the planning process. The value of the site analysis will be realized fully many years down the road, when it will serve as a reference for determining how closely the product of revegetation and succession resembles the target community.

Revegetation Monitoring

Monitoring procedures utilize both microplot and ocular survey methods, and involve recording many of the same plot characteristics that site analysis does: Ground cover, species cover, erosion status, vegetation structure, and disturbance history. In the long-term, these data will allow successional trends to be followed to determine the timeframe in which components of target communities establish, or to reveal that the target community was not a reasonable goal for the area, given our methods. In the short-term, by systematically revisiting monitoring sites and recording, for example, exotic species presence, germination of seeded species, and vigor of planted shrubs, we will be able to identify areas where we need to improve our techniques.

Four monitoring schemes of increasing complexity have been devised, suited to different needs. The intensity of monitoring required for each area depends on the revegetation measures applied, site location, and likelihood of the site's being problematic due to factors such as continued disturbance, poor soil, or slope.

A backcountry campsite that has been blocked off, seeded, and mulched is appropriate for very basic Level I monitoring. The questions of interest here, rapidity of site recovery and exotic presence, are addressed readily by ocular plot estimates of ground cover and canopy cover of trees, shrubs, herbaceous species, and noxious weeds. No specific data about revegetation species are collected. This rapid site assessment is intended to flag any area that needs remedial action due to exotic encroachment, erosion, or continued disturbance.

Level II monitoring is the backbone of Glacier's program and has been used extensively. In addition to making a general evaluation of soil surface status and total vegetation cover, the monitor makes species lists of at least the dominant exotic and native species present. Mortality, growth, and vigor of planted shrubs and forbs is quantified, as are cover, density, and reproductive status of seeded species. This level addresses success of revegetation measures and may prompt changes in procedure. For example, numerous exotic species were recorded in monitoring plots on imported soil used at a construction site, while salvaged soil in the same area had very low exotic cover. These observations suggest the use of unpasteurized imported topsoil is questionable.

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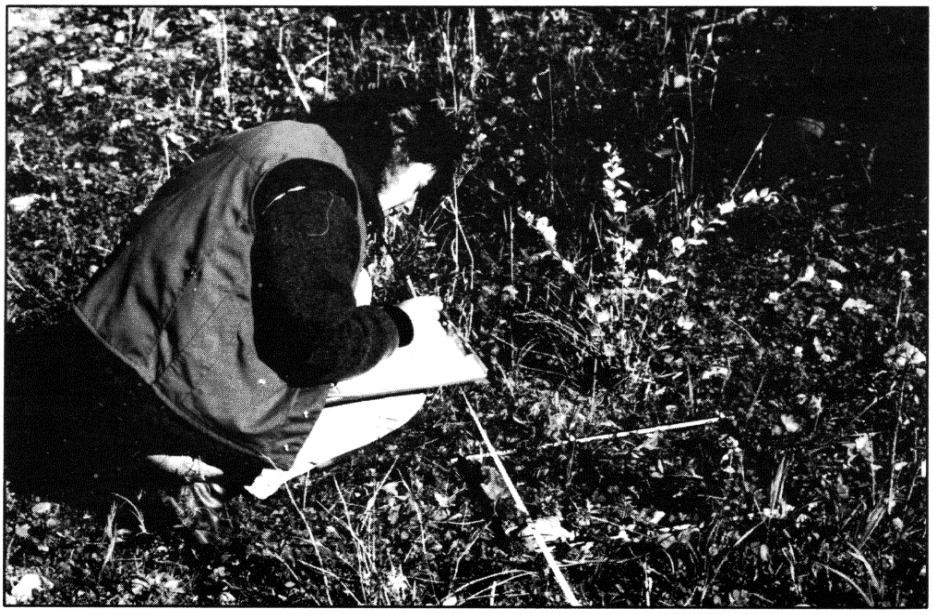
Rachel Potter, Biological Technician, collects microplot data from a roadside revegetation site.



Olympic Revegetation Efforts Continue to Evolve

By Edward Schreiner and Ruth Scott

Revegetation in the backcountry of Olympic National Park (OLYM) began in 1975 as a strictly seat-of-the-pants operation. We would judge which campsites and trails had unacceptable levels of human impact, close them, and move plants into the sites from nearby. The learning curve was steep—we had spectacular failures and moderate successes. We learned, among other things, that survival of transplants from nearby locations was variable, depending on plant size (i.e. neither too big nor too small) and weather conditions at the time of transpanting (i.e. best when cool and rainy).

Our early efforts, while well-meaning, have evolved into a more organized program. We now use native plants propagated in a greenhouse from seeds and cuttings. Most reveg work is conducted in the fall, resulting in higher survival rates. Revegetation priorities are based on parkwide surveys of human impact, visitor use levels, and wilderness classification. We use transplanted vegetation (that which is not produced in the greenhouse) only under limited circumstances such as small-scale fire line restoration projects (i.e. not on the scale of Yellowstone fire lines).

The OLYM revegetation program has improved from the early days, but new issues require resolution. Raising plants in a greenhouse has increased plant survival in restoration sites and also allows us to obtain materials for propagation from more locations, but the latter carries the risk that, however unintentionally, we could alter the genetic makeup of park ecosystems. Most debate seems to center around setting a maximum distance away from revegetation sites for collection of propagating materials.

We recognize that maintaining the genetic integrity of park ecosystems is an important and worthy goal. We also believe common sense needs to be part of the decision-making process. This means considering reproductive mechanisms, wind patterns, and the relative abundance of species selected for revegetation. For example, it makes sense to collect the seeds of common wind-pollinated conifers from sites with similar elevation in the same river valley as the reveg site. Equally, seeds of plants pollinated by insects with limited flight distances should be collected from very close to the reveg site. We feel that setting an arbitrary maximum distance away from revegetation sites for collection of propagating materials makes no sense.

We realize this view is not shared by everyone and that it is time to engage in serious dialogue to resolve the issue. However, we do not believe this complex problem has a simple answer. The entire matter raises questions that need intensive, informed thought:

(1) Should we be attempting to restore sites to look like the surrounding vegetation, or should we restore early successional (but native) species and let nature take over from there?

(2) Are non-native, sterile species (like sterile wheat) appropriate to help stabilize slopes prior to native species taking over?

(3) Is it appropriate to restore the soil profile, and if so, how many soil amendments are appropriate (fertilizer, peat moss, steer manure, etc.)?

(4) What should we use when fill material is required but only soil of different parent material and characteristics is available?

Ultimately, we would like to see revegetation develop in direction of restoration using the equivalent of silvicultural prescriptions. This could involve assessing expected mortality rates (by species) in advance. Thus, compensating measures such as planting at extra-high density could be taken. We feel that we and other parks have made significant progress, but we realize that much remains to be learned. The questions listed here might serve as a useful beginning.

Schreiner is a Plant Ecologist with the NBS; Scott is a Resource Management Specialist and runs the revegetation program at Olympic NP.

Revegetation Monitoring continued from page 6

A Level III monitoring procedure involves establishment of permanent microplot and shrub transects to collect data suitable for statistical analysis. This level has been utilized in deleted turnouts along the Lake McDonald section of Going-to-the-Sun Road, where half of each turnout was seeded and half was not. Data will be analyzed for (1) establishment and growth of seeded species, (2) relationships between native species seeding and exotic species cover, and (3) survival and growth of nursery stock (Potter, 1992).

In some circumstances, a Level IV experiment may be appropriate to evaluate effectiveness of various combinations of revegetation treatments. Two Dog Flats grassland in the St. Mary valley was disturbed by road construction in 1992, and the most effective means for restoring native vegetation along the roadside , while discouraging exotic establishment, was not known. A study presently is underway to evaluate the effects of (1) the slope-stabilizing nurse crop Re-green (a sterile wheat hybrid), (2) herbicide application, and (3) seeding of native species on the establishment of native and exotic vegetation.

This study is a collaborative effort between Dr. Rob Tyser of U/WI-LaCrosse and the park's reveg staff. Level IV monitoring methods are not standardized, but in this case rely on canopy cover data from randomly located microplots. Another Level IV study, investigating various mulches, is anticipated.

Management Implications

Although the monitoring program in Glacier is still in its infancy, the results of the first full season's monitoring efforts are promising. In the past, target communities have not been described in detail for use by park reveg planners. Resource managers' ideas and notes about the success of reveg treatments in various sites have not been recorded systematically.

This monitoring strategy compiles all data about the site, from both site analyses and post-reveg monitoring, into one computer database. Computer programs are being developed to facilitate rapid report generation. Years of records will indicate how long it takes for a revegetated site to begin to resemble the target community, or will reveal that our goals are not realistic. Data review with respect to reveg practices (species selection, mulch use, topsoil application, time of seeding) may prompt us to change our methods.

Glacier NP is trying to get away from practices that merely "patch up" disturbed areas and make them green again. By adding this dimension to our revegetation program, we hope to learn to fine-tune our methods and thus come closer to approximating the original pre-disturbance community.

Vanderbilt is a Biological Technician at Glacier NP.

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How to Prepare Vegetation Overlays as Accomplished at Harpers Ferry

By Fred C. Collins, Russell G. Combs, James L. Smith, and William Hebb

Harpers Ferry National Historic Park (HFNHP) is in the process of developing an extensive spatial database for its geographic information system (GIS). Aerial photography of the park and adjacent lands was obtained for the purpose of developing a vegetation overlay. Personnel in the Department of Forestry at Virginia Tech (VT), stereoscopically examined aerial photographs in order to identify and delineate vegetation types and prepare the vegetation overlays necessary for entry into the GIS. The purpose here is to describe the process we used to develop this vegetation information, and what we learned about this process for those who will perform similar tasks in the future.

Creation of Vegetation Overlays

The first step in any mapping project is to define a classification system. Seven classes were defined, covering forested and non-forested land. The Non-Forested classes included non-vegetated developed land, vegetated developed land, agricultural land, and water. The Forested classes included hardwoods, conifers, and mixed hardwoods and conifers. A Five (5) acre minimum mapping unit was specified. The selected classes are shown in Table 1.

The creation of the 37 vegetation overlays involved a number of steps. First, photo interpretation of the 1:24,000 scale normal color aerial photographs was performed. We had four sets of aerial photos available to create the vegetation overlays: 1:24,000 scale normal color leaf-off, 1:3,000 scale normal color leaf-off, 1:12,000 scale CIR leaf-on, and 1:12,000 scale leaf-off. Only the 1:24,000 scale normal color photos, however, provided complete coverage of the entire region of interest. Of the 17 normal color photos in the set, 6 were chosen that covered the area of interest. For each of 6 photos, mylar overlays were photo interpreted using an Old Delft Scanning Stereoscope. Photo mylar overlays are vegetative classifications traced on mylar over the photographs of the region of interest. Color, texture, shadow pattern, size, and shape of the region of interest were used to assist in classification.

Ground Survey

Next, a preliminary ground survey was conducted to evaluate the photo interpretation. From this initial ground survey, there appeared to be some error in the original interpretation of the photos, particularly in the differences between P and MIX and between MIX and UPH. Very little of what was initially called MIX on the photo appeared to be MIX on the ground. Most of what was called MIX was in fact UPH. Where available, additional CIR photo information was then used to re-examine these cover types.

The initial ground survey and examination of the CIR photos showed the need for a more extensive ground survey. A second field check was performed to re-evaluate the photo interpretation after the changes made following the first field check. During the field check, we concentrated mainly on areas that were classified as either P or MIX to determine their accuracy. The second field check resulted in changing a great deal of P and MIX areas on the photo mylar overlays to UPH. We determined that our errors in classification were due to a misinterpretation of hardwood (deciduous) species that had already leafed-out as MIX and P. In addition, some ground cover that had leafed out in the hardwood regions may have caused us to interpret some UPH regions as MIX. Changes in photo interpreted information were made according to the results of the second field check.

The photo interpreted information was then transferred to base maps of the park. A Bausch and Lomb Zoom Transfer Scope (ZTS) was used to assist in the transfer of the classified aerial photos onto the base maps. The ZTS was used because the transfer from the normal color 1:24,000 scale aerial photos involved both a change in scale and image geometry. The ZTS uses mirrors, back-lit screens, variable lighting, and optics to allow the user to superimpose and trace the vegetation overlay onto the desired base map. The vegetation overlays contain the same information as the photo mylar overlays at the scale of the base maps. The "zoom" and "skew" controls on the ZTS were used to match to scale of the photo mylar overlay with the scale of the base map and to account for geometric distortion in the photographic image.

Distortion Causes

Geometric distortion is the combined result of optical distortion from inferior lenses, tilt, aircraft motion; and relief displacement. Campbell (Campbell, James, B., "Introduction to Remote Sensing," The Guildford Press, 1987.) states that "the most important source of positional error [geometric distortion] in vertical photography is probably relief displacement." Relief displacement causes objects to appear to lean away from the center of the photograph as one moves towards the photo's edge. Uneven terrain, such as encountered at HFNHP, significantly increases relief displacement making the matching of vegetation overlays and bases maps difficult at times.

The ZTS used by Virginia Tech was slightly modified by raising the instrument approximately 6" on stable wooden blocks to increase the areas that could be transferred at

Table 1. Selected Classes

Class	Definition	Appearance on Normal Color Photo
DVC	Developed with Vegetative Cover	Some roads interspersed among the green textured areas. Some buildings visible as white rectangles.
DVN	Developed without Vegetative Cover	Interspersed with white lines and blocks representing roads and buildings. Little vegetation.
AGR	Agricultural Land	Regular patches of green and light brown, smooth in texture.
WAT	Water Areas	Dark, smooth textured areas. Sometimes bright or sparkled because of sunlight reflection.
UPH	More than 70% upland hardwood Species	Overstory brown or a light pale green. Coarse textured. Most prevalent category.
P	More than 70% Conifer	Dark green vegetative overstory. Coarse textured and irregular in shape.
MIX	Less than 70% of Conifers or Deciduous	Interspersed dark green, and brown overstory. Coarse textured and irregular in shape.

one time. This modification did not appear to increase distortion. Very little of the ZTS's "stretch" function was used in the transfer of the image as stretching did not appear to help in matching the two images. Manual alignment of the base map and the aerial photo followed by slight adjustments with the ZTS's controls worked best. Usually, one or two distinct man-made features such as a roads or buildings were used to align the two images. Where no man-made features were present on the base map, the matches and subsequent transfer were approximate at best.

Lessons Learned

The selected classification system must contain information relevant to the user and be achievable using the imagery at hand. These two goals were fulfilled through close cooperation and communication between those making the maps (Virginia Tech) and those using the maps (HFNHP). This step always requires some compromise. Having appropriate aerial photographs of the region of interest is important in the creation of vegetation overlays. For the Harpers Ferry Project, we had four sets of aerial photos available to create the vegetation overlays. Unfortunately, only the 1:24,000 scale normal color photos covered the entire region of interest. The additional photos in conjunction with ground surveys were used to verify the photo interpretation. Normal color aerial photographs were not as effective as CIR photographs for vegetative classification. Conifers and deciduous trees both had similar appearance on the normal color photos. In the CIR photos, the differences between conifers and deciduous trees was more pronounced. The second field check resulted in changing a great deal of conifers and mixed areas on the photo mylar overlays to hardwoods. Using CIR leaf-off photos from the onset would have reduced changes to the photo mylar overlays. Having CIR photos of the entire region of interest would improve the quality of vegetation overlays for use in GIS.

Film type, scale, and season of acquisition greatly influenced the effectiveness of the photo interpretation. The normal color, 1:24,000 scale photos suffered most from an early Spring acquisition where hardwoods were just leafing out. These hardwoods appeared similar to conifers in the photos and were a cause of error and confusion. Paine (Paine, David P., *Introduction to Aerial Photography For Natural Resource Management,* Published by O.S.U. Book Stores, Corvallis, Oregon, 1977.) lists the advantages of CIR films as:

1. Much better penetration of haze.
2. Emphasizes water or moist areas.
3. Good differentiation between hardwoods and conifers.
4. Sick, dying or vegetation under stress is more easily detected.

By studying aerial photographs of different scales, we concluded that scales between 1:12,000 and 1:18,000 would be optimal for vegetation classification of this type. The 1:3,000 scale photos were of too large a scale, had excessive relief distortion, and suffered from the same classification problems as the 1:24,000 scale photos. The 1:24,000 scale photos used in the study did not show enough detail to distinguish some vegetation types.

The leaf-on CIR photos were of acceptable scale, but in the leaf-on photos, most vegetation appears red. It is possible to distinguish between conifers and hardwoods by the color variations, but it is difficult and unnecessary. The CIR leaf-off photos differentiate between conifers and hardwoods distinctly. Hardwoods appear as dark brown while conifers appear as dark red.

Our recommendation for future photo interpretations is to procure CIR photos for the entire region of interest at a scale between 1:12,000 and 1:18,000 in Winter prior to vegetation leaf-out. The Normal Color film used in this study suffered from being taken at a transitional time where some hardwoods were just leafing out. Normal Color film maybe more effective if taken during a period of complete leaf off. The film types are summarized in Table 2.

In the Harpers Ferry Project, some vegetation overlays were classified from three or more photos. These overlays suffered from utilization of information near the edge of the photo effective area where relief displacement is greatest. The effects of this displacement was evident when edge-matching the 37 vegetation overlays. The large change in scale and relief distortion resulted in some lines being off by as much as .25" between two vegetation overlays. Where possible, the photo mylar overlays were consulted in an attempt to match the vegetation overlays. Forced edge-matching of the 37 vegetative overlays, while possible, would not reflect the data inaccuracies resultant from manual photo interpretation, scale changes and relief distortion. It is recommended that the maximum number of photos per vegetative overlay be two, and that one is ideal. In the Harpers Ferry Project, the overlays requiring the greatest number of photos showed the greatest relief distortion. As photo scale is reduced, the number of photos per overlay increases with subsequent increases in relief distortion. A trade-off can therefore be seen between increased detail and increased relief distortion.

Conclusions

Having aerial photographs of correct scale, film type, and date of the region of interest minimizes effort in the creation of vegetation overlays for use in GIS. In addition, ground surveys are critical to verify the photo interpretation. While the ZTS is an effective tool for the transfer of cover type information from photos to mylar overlays, where there are no identifiable man made features, the ZTS is not very helpful. CIR photos, leaf-off, were most effective for delineating among forest cover types. Ideally, CIR photos, leaf-off, of a scale between 1:12,000 and 1:18,000 should be taken for the entire region of interest. In choosing stereo pairs, care should be taken to limit the number of photos per overlay to two (2) where possible.

Collins and Combs are graduate students and Jim Smith is their faculty advisor, Dept. of Forestry, VA Tech. Hebb is Resource Management Specialist at Harpers Ferry HNP.

Table 2. Summarization of Film Types

Film Type	Scale	Season	Appearance of Conifers	Appearance of Hardwoods	Comment
Normal Color	1:24,000	Early Spring	Dark Green	Brown or Light Green	Not enough detail. Timing poor, hardwoods just leafing out —look like conifers.
Normal Color	1:3,000	"	"	"	Difficult to classify vegetation types. Relief distortion excessive.
CIR	1:12,000	Leaf-on	Light Pink to Red	Darker Pink to Reddish color	Difficult to distinguish between conifers and hardwoods.
CIR	1:12,000	Leaf-off	Pink to Red	Brown	Best of vegetative classification, easy to distinguish between conifers and hardwoods

Notes From Abroad

By David A. Ek

During the last two weeks of July, I participated in a 16-member cave and karst management delegation to the People's Republic of China. The trip was organized through auspices of People to People, Citizen Ambassador Program. My own money was used for this trip and I was granted annual leave from Fort Clatsop National Memorial, where I am the Resource Management Specialist. Prior to Fort Clatsop, I was Assistant Cave Resource Management Specialist at Carlsbad Caverns NP.

The trip's purpose was to foster and develop exchanges with professional counterparts and to build a broader perspective toward worldwide cave and karst concerns. We obtained official permission for the U.S. to conduct a cave exploration in Spring 1995. Information on the structure, organization, etc., of the Institute of Karst Geology also proved valuable.

The delegation leader was Cave Specialist Ronald C. Kerbo from the NPS Southwest Regional Office. Except for myself, the delegation members were from the National Speleological Society or the Cave Research Foundation.

Our delegation flew into Beijing, capital of the People's Republic of China, where we met with members of the China Association for Science and Technology, who hosted our visit. From Beijing, we traveled south by air and bus to Southeast China, stopping to visit developed caves, wild caves, and non-cave areas along the way. The non-cave areas included the Hunan Geologic and Mineralogic Museum, the Great Wall, the Ming Tombs, a Tao temple, the Forbidden City, a cruise on the Li River, many mighty fine (real) Chinese restaurants, and portions of the incredibly beautiful tropical and sub-tropical countryside of southeastern tropical and sub-tropical countryside of southeastern to east-central China.

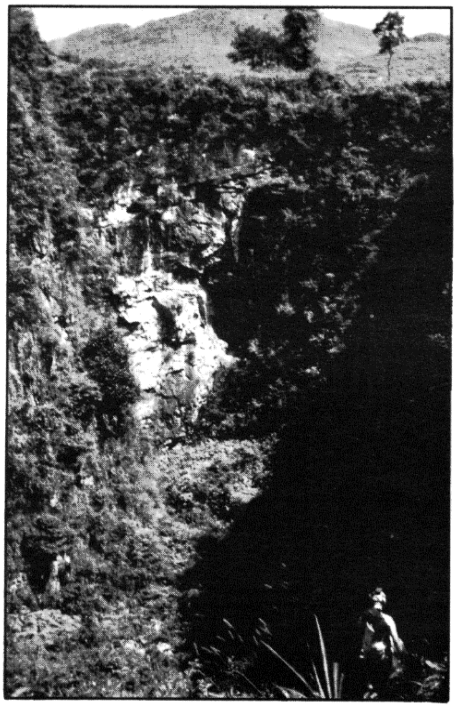
Having the opportunity to see the country and visit with the people was a most rewarding aspect of the trip. I learned a little about the culture and experienced first-hand the rice fields near Chenzhou, the high-pressure

Villagers in southeastern China working in their fields. *(PHOTO BY DAVID EK)*

souvenir booths along the Great Wall, eating pig lung and ears, eel, rat and chicken feet, and walking through the markets and back alleys of a city of 11 million.

Due partly to the large population, long human history, and poor economy, the caves, karst, and water resources of China have been highly impacted. Threats of particular concern include nearby coal mining and other resource extraction activities as well as pollution and siltation from agricultural practices. Unlike the situation in the U.S., most of China's karst regions lie in the valleys between the lowland cities and the agricultural areas on higher plateaus and hillsides. This condition allows all the chemicals, silt, and other agricultural by-products to pollute the caves. Since caves serve as efficient conduits to the groundwater, in a relatively short distance large aquifers and countless people are affected.

Dr. Ron Delano approaches Songjadong Cave. The cave entrance is out of sight in the bottom of the sinkhole. *(PHOTO BY DAVID EK)*



To begin to understand and deal with these many threats, China has created an Institute of Karst Geology research center in Guilin, China. The Institute has many knowledgeable and talented people associated with it; however, funding is very poor. For instance, they are awaiting their first computer and FAX machine.

While at the Institute of Karst Geology, our delegation presented five papers. Kerbo gave a paper on caves and cave management within the NPS. John French discussed a statistical model he developed for a karst area in Alabama that predicts cave entrance locations. Bob Handley presented a paper on historic explorations of the Organ Cave System in West Virginia. Ron Delano's paper dealt with recognizing and compensating for parallax diffraction while conducting cave surveys. My paper concerned biologic inventory and environmental preference investigations of epigean fauna within Carlsbad Caverns NP.

During one of our exchanges, we discussed the worldwide importance of cave and karst resources. Karst comprises approximately 12 percent of the world's landforms. The People's Republic of China and the U.S. contain some of the world's most extensive karst. As examples of their importance, China contains approximately 17 percent of the world's 20 million square kilometers of karst, while 25 percent of U.S. fresh water resources is held in karstic landforms.

China has for hundreds of years recognized the importance of caves and karst to water quality and the health and economy of the public. In China, unlike the U.S., the

primary interest in caves is for scientific (principally hydrological) research. In the U.S., the leading interest in caves is recreational. Much research is taking place in U.S. caves, but it does not come close to the scientific potential that caves hold. Many advanced research topics in hydrology, paleontology, biology, sedimentology, mineralogy, and global climate change are best answered in the unique environment of caves. Responsible research in caves at this level began only fairly recently. In spite of their wide distribution and scientific importance, caves have largely been ignored or misunderstood by the U.S. scientific community, and even at times by the NPS.

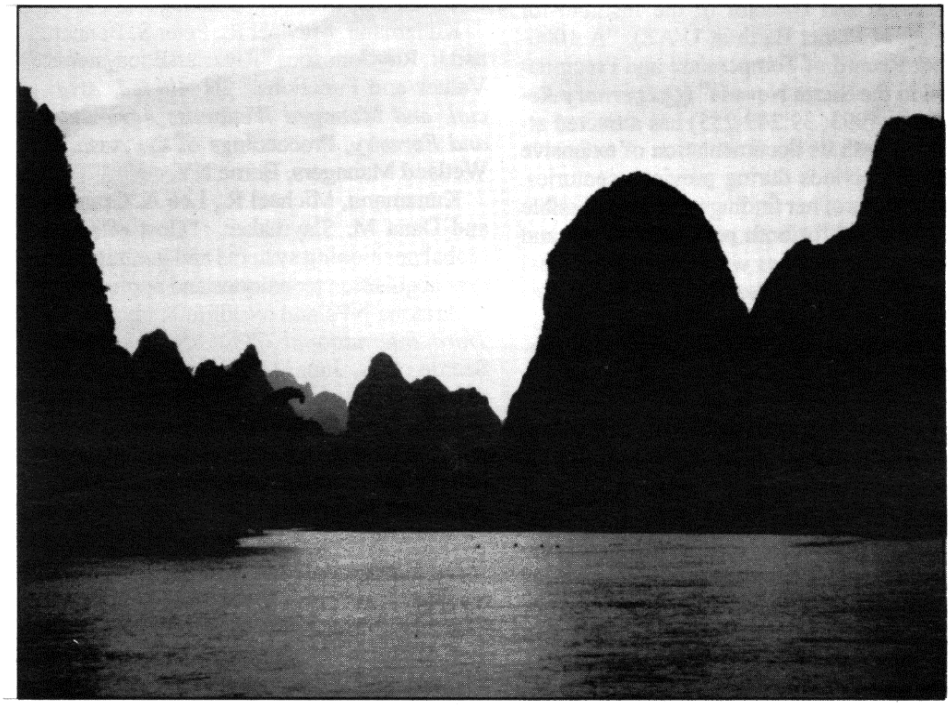
Caves are an important and unique biome within the National Park System. Sixty NPS units (17%) are known to contain cave resources. They occur throughout all Regions, particularly the Western, Rocky Mountain, Southwest, Southeast, and Pacific Northwest. The number of NPS positions created to deal specifically with these numerous and unique resources are: four to five at the park level, one at the regional level, and one with policy contact duties at the national level.

Impacts to caves are not unique to China. Coal mines in West Virginia and gas exploration in New Mexico are currently posing a tremendous threat to world class cave resources. Siltation from logging activities in Washington and Alaska are impacting caves and compromising their value for research. Entire cities in Kentucky have highly contaminated groundwater due to sewage and other contaminants being dumped into sinkholes. Significant archeological resources are being destroyed within caves in Arizona and Hawaii. The list goes on and on.

To deal effectively with these and other threats within the U.S., managers and researchers need to develop a more appropriate and responsible level of concern and attention toward caves and karst. More cave-related positions need to be established and a cave research facility and information repository developed. Still far behind China, the NPS is in the process of developing a Cave Research Institute in this country.

It was rewarding to visit Chinese caves, meet with fellow managers and researchers, and share information and ideas. Caves are a unique and much misunderstood resource. In light of the increasing threats to these resources in both countries, a more coordinated approach, at regional, national, and international levels, can be seen as necessary in order to deal with the complex issues involved.

Ek is Resource Management Specialist at Fort Clatsop National Memorial in Astoria, OR.



Tower Karsts just a few of the thousands located along the Li River in southeastern China. *(PHOTO BY DAVID EK)*

Isle Royale Wolf/Moose Update

The 36th annual wolf/moose winter monitoring program at Isle Royale, still in progress as the deadline for this issue of *Park Science* arrives, has produced surprising results.

When park staff left the Island last fall, only 11 wolves remained. Based on the last several years of intensive research and monitoring, the predicted future for the Isle Royale wolves was of eventual extirpation, primarily due to loss of genetic variability. In short, despite an apparent lack of disease problems and ample food supply, the wolf population was not rebounding from historic low levels.

Imagine the surprise and excitement of the park staff and principal investigator Rolf Peterson when 18 wolves were found in January. Even more importantly, for the first time since 1988, more than one pack successfully raised pups to winter. Two of the three packs produced young; the Middle Pack produced four pups, while the East Pack also produced four. The alpha male of the Middle Pack died in January, so the current count is 17, although there is a loner still unaccounted for on the Island. The eight pups surviving to winter represent the largest number of pups in several years.

Information on the moose population is less complete at this time, although the population is expected to be at similar levels to 1993—that of about 1,900 animals (the highest population in approximately 60 years).

Finally, another rare event—the forming of an ice bridge from Isle Royale to the North Shore of Minnesota and Canada (approximately 15 miles across Lake Superior)—has occurred during this severe winter, offering at least the potential for immigration of wolves to the Island. The original movement of wolves across the ice to the Island in the late 1940s, the foundation for the existing wolf population, was an extremely rare event. It would take another rare set of circumstances were it to happen again.

Jack Oelfke
Isle Royale Natural Resource Specialist
Dr. Rolf Peterson
Michigan Technological University

Regional Highlights

Southeast Region

The natural resource management program at Mammoth Cave NP received well-deserved recognition recently, when its staff swept all three of the Southeast Region Natural Resource Awards, and Supt. Dave Mihalic was named the Director's Superintendent of the Year for Natural Resource Stewardship.

Mammoth Cave Resource Mgt. Chief Jeff Bradybaugh earned the Region's Natural Resource Management Award. He has fostered a solid scientific approach to understanding the resources of Mammoth Cave NP, and has designed a comprehensive research program involving partnerships with universities, agencies, organizations, and individuals; he has professionalized the Division of Science and Resource Management and has coordinated an interagency effort to develop a program focused on protection of groundwater integral to cave resources.

Joseph Meiman was the Region's winner in the research category. Joe has sought to protect the integrity of the subsurface ecosystem of Mammoth Cave NP and the surrounding International Biosophere Reserve. Focus has been on the strategic acquisition of scientific information necessary to demonstrate impacts on groundwater quality and understand the mechanics of pollutant transfer. He has designed and completed numerous scientific studies since being hired in 1989.

Mihalic has addressed park resource management issues from a sustainable ecosystem perspective throughout his tenure at Mammoth Cave. In addition to initiation of an International BR, he has worked to protect, manage, and resolve issues affecting the aquatic ecosystem and has participated in local programs to improve the general welfare, health, and economy of the rural Mammoth Cave area. Supt. Mihalic and the park have received national recognition for these efforts in the form of the 1993 "Innovation Award" from the National Association of Development Districts.

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Virgin Islands NP reports that 17 permanently buoyed anchors have been placed to reduce anchor damage to marine benthic communities. The U.S. Navy is assisting the park in installing 17 to 23 additional moorings. The park also has closed two bays on the south shore to anchoring. The "mooring only" areas allow visitor use while protecting important research sites, seagrass beds, and the endangered green sea turtle that feeds on seagrass.

The park also has established a DOS based GIS system manipulated by IDRISI and ArcCad software. Several major themes are digitized and ready for use, including vegetation, elevation, marine benthic communities, historic structures, archeological sites, endangered species, and transportation. Contacts for more information on the mooring program or the GIS system are Jennifer Bjork and Tom Kelley of Virgin Islands NP.

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Recently published reports:

Boulay, M.C. 1992. ***Mortality and Recruitment of White-Tailed Deer Fawns in the Wet Prairie/Tree Island Habitat of the Everglades***. Master's thesis, U/FL, Gainesville.

Miller, K.E. 1993. ***Habitat Use by White-Tailed Deer in the Everglades: Tree Islands in a Seasonally Flooded Landscape***. Master's thesis, U/FL, Gainesville.

Sargent, R.A. 1992. ***Movement Ecology of Adult Male White-Tailed Deer in Hunted and Non-Hunted Populations in the Wet Prairie of the Everglades***. Master's thesis, U/FL, Gainesville.

Zultowsky, J.M. 1992. ***Behavioral and Spatial Ecology of Female White-Tailed Deer in the Everglades Ecosystem***. Master's thesis, U/FL, Gainesville.

Western Region

A recent publication by Dr. Lisa Graumlich (Professor at the Laboratory of Tree-Ring Research and Director of the Institute for Study of Planet Earth at U/AZ), "A 1000-Year Record of Temperature and Precipitation in the Sierra Nevada" (***Quaternary Research***, 1993; 39:249-255) has attracted attention with its documentation of extensive drought periods during previous centuries. Summaries of her findings and their possible implications for both park ecosystems and State water supplies were covered by local newspapers and by the *New York Times*. Dr. Graumlich is a principal investigator on the Sierra Nevada global change research program.

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Research Scientist David Parsons has been asked to serve on an ad hoc committee on ecosystem management by the Ecological Society of America (ESA). NPS representation in such activities is critical in building the credibility of NPS science activities as well as in assuring the results of the committee are applicable to park issues. Dr. Parsons also has been asked to serve as a member of an independent science team appointed to assess the current status and management alternatives for old growth and associated ecosystems of the Sierra Nevada. This study is mandated by Congressional legislation.

Parsons continues to serve on the Board of Editors for the ESA journal, *Ecological Applications*, which is interested in publishing more articles related to NP resource issues. Potential contributors can contact Parsons at Sequoia and Kings Canyon NPs. Parsons currently is working on a special series of papers on threats to wilderness and parks, to be published in a special issue co-edited by David Cole of the USFS Wilderness Research Institute in Missoula, MT.

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Under the direction of Dr. Bill Halvorson, the U/AZ CPSU has published ***Proceedings of the Fourth California Islands Symposium***. The symposium was held March 23-25, 1993 in Santa Barbara, CA. Copies may be purchased from the Santa Barbara Natural History Museum, 2559 Puesta del Sol Road, Santa Barbara, CA 93106, (805) 682-4711.

The following articles by A/AZ CPSU staff have been accepted for publication:

Christopherson, Gary L., D. Phillip Guertin, Michael R. Kunzmann, Kenneth L. Kvamme, and Thomas Potter, (1993). "Comparison of interpolation algorithms for digital elevation model generation and subsequent viewshed analysis," IN *Proceedings of the First Biennial Conference on Research in Colorado Plateau NPs*, pp 226-233. Available through NAU-CPSU, ISSN 0270-8655.

Kunzmann, Michael R., Peter S. Bennett, and R. Roy Johnson. "Riparian Ecosystems: Values and Functions." IN *Altered, Artificial, and Managed Wetlands: Agriculture and Forestry*, Proceedings of the Assn. of Wetland Managers, Berne NY.

Kunzmann, Michael R., Lee A. Graham, and Dana M. Slaymaker. "Cost effective global positioning systems and geolink field data acquisition techniques and applications in Arizona NPs and Wildlife Refuges," IN *Third International CPS/GIS Conference*, Seattle, WA, June 23-25, 1993. Available through GeoResearch Inc., Billings, MT.

Kunzmann, M.R. and P.S. Bennett, "Suppression of Saguaro cactus flower bud formation by roosting vultures in Arizona." *Southwest Naturalist*.

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Dr. George Ball and Michael Kunzmann received a research grant from Southwest Parks and Monuments to continue work on the "Analysis of historic fire data using spatial modeling techniques for Chiricahua National Monument."

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Regional Highlights

Development of a prototype social science research plan is one of the Western Region's exciting new starts. Project workers include Bill Halverson, Jim Holland, Donna Chickering, and Liudyte Novickis. Their project is scheduled for summer completion.

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For one of the livelier accounts of ongoing research and resource management anywhere in the Service, read Joan Ford's regular column in ***Bajada***, published (and free) three times a year by the NBS CPSU at U/AZ. Ford is an administrative clerk for the CPSU and obviously in touch with everything going on around there.

Mid Atlantic Region

Tom Blount, Shenandoah NP I&M Program Manager, along with four cooperating researchers from U/VA, presented papers at the Mid Atlantic Highlands Environmental Monitoring and Assessment Conference in Hershey, PA Feb. 23-25. Session topics included an overview of progress on the park's Long-term Ecological Monitoring Program and trend information gained from analysis of aquatic resource datasets.

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Research and Resource Planning Division of Delaware Water Gap NRA and the Delaware River Basin Commission (DRBC) met with representatives of NC/State/U's Computer Graphics Center to continue development of a water quality model for the entire upper Delaware basin—over 4,000 square miles. This model will allow analysis of the effect on water quality of proposed developments within any of the more than 70 tributary watersheds in the upper Delaware basin.

The model will be linked to the Delaware Water Gap NRA's GIS at Peirce House. This linkage will allow examination of the effects of potential threats to the Delaware water quality anywhere in the upper basin, and will be a means by which water quality and resource management specialists, under the auspices of the DRBC Special Protection Waters program, can conduct long-term areawide water quality management.

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A pre-settlement-origin chestnut oak forest in French Creek State Park, adjacent to the Hopewell Furnace NHS boundary, was discovered in the course of a recent research project. The study investigated the community ecology of an old growth chestnut oak forest on a dry talus slope. Chestnut oaks up to 367 years old dominate the canopy layer. Ironically, this community is situated near the center of a 19th Century charcoal iron settlement, where area forests repeatedly were clearcut on short rotations for fuel.

This discovery permitted the construction of a 367-year living tree-ring chronology, which may be used in the future dating of historic structures at Hopewell Furnace NHS.

Pacific Northwest

On February 3, PNR representatives met with consevation organization leaders to discuss "Nature Has No Borders," the March 25-27 Conference on the Protection and Management of the Northern Cascades Ecosystem, on the U/WA campus in Seattle.

At that meeting, the Freeman Tilden Award was presented to Barb Maynes, District Interpreter at Olympic NP, and the Tilden Sponsorship Award was given to Supt. Maureen Finnerty for supporting interpretation activities at Olympic.

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Fort Clatsop National Memorial Supt. Cynthia Orlando was in Washington, DC the last week of January to brief the Oregon Congressional delegation on the draft General Management Plan/EIS for Fort Clatsop.

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Assoc. Reg. Dir. Mike Tollefson attended a January meeting in Virginia, called by Destry Jarvis, to help the NPS develop a Public Land Corps program, part of the National Service Corps, slated to be in place by this summer.

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The Region has been asked by the Student Conservation Assn. to help SCA put on "Earth Week Seattle" May 21, 1994. Regional Chief Ranger Reed Jarvis has been assigned as the Region's representative on the SCA steering committee. NPS will be a partner in providing logistical and staff support and will assist at some of the 1,000 proposed work sites in the City of Seattle. Focus of the event is to unify communities in urban environmental restoration and beautification projects while creating your-round support for SCA's education and work program.

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Managers from Olympic NP, Olympic NF and the WA Dept. of Natural Resources met Jan. 20-21 in Port Angeles, WA. The meeting, whose theme was "Reinventing Government on the Peninsula," afforded managers a chance to become better acquainted with one another's programs and to discuss ecosystem management, interagency cooperation, and providing better public service.

Southwest Region

The SWR's Division of Natural Resources held a week-long Resource Management Workshop in January. Over 130 attendees heard presentations on topics such as compliance and consultation, resource stewardship, the interrelationships between natural and cultural resources, how to write good proposals and project statements for park resource management plans, information on funding sources, and the role of Geographic Information Systems in resource management.

Maria Burks presented a session on resource stewardship and the Vail Agenda; Deputy Regional Director Mary Bradford opened the workshop with a talk on her views of resource management as part of park management and the relationship between the parks and the regional office; and David Simon, the keynoter, spoke on the purpose and role of the National Parks and Conservation Association and its administrative and legislative agendas.

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On January 31, the New Mexico State Director for the BLM signed a Record of Decision for the Dark Canyon Environmental Impact Statement. This EIS was prepared by BLM to assist them in deciding how to manage oil and gas leases adjacent to Carlsbad Caverns NP near the known passageways of Lechuguilla Cave. NPS was a cooperating agency in preparation of the EIS.

The decision made by BLM was endorsed by NPS; it sets a new standard for protection of cave resources by BLM. A cave protection zone was established and drilling for oil and gas in this zone will not be permitted. Outside this zone, special precautionary measures for oil and gas activities will be required. These measures also will be used by BLM in other karst areas to protect cave resources.

Midwest Region

In an effort to understand some of the more subtle, yet important, anthropogenic impacts on parks, Walt Loope, Research Ecologist focused on one lake in Pictured Rocks National Lakeshore to determine how it had been altered by placement of a lowhead dam across the outlet. The dam was installed in the early 1900s to raise creek and lake levels in order to float logs to Lake Superior.

He found that many of the lake's characteristics, previously attributed to natural phenomena, probably were caused by the dam. The report, titled "Evidence of Physical and Biological Change Within the Beaver Lake

Continued on page 14

Regional Highlights

Watershed Attributable to a Turn-of-the-Century Logging Dam," can be had by contracting Brian Kenner at Pictured Rocks, (906)387-2607.

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All monitoring efforts in 1993 indicated that zebra mussels did not become established in waters of the Saint Croix National Scenic Riverway...an unexpected but very welcome outcome of the 1993 zebra mussel response program. The 1994 program, supported by a special appropriation from Congress, will include a critically needed assessment of the zebra mussel risk along the 405 - kilometer length of the St. Croix. The limited information available in scientific literature indicates that at least the upper reaches of the river may not have high enough levels of calcium to allow for zebra mussel establishment. Water quality characteristics of the St. Croix will be mimicked in lab tank studies to assess the risk of zebra mussel colonization in various reaches of the river.

* * *

Twenty-nine Region employees attended the Georgraphic Information Systems October 1993 workshop at the GIS Field Technical Support Center (FTSC) at the U/WI-Madison. The workshop aimed to establish common ground for building a Regional GIS program. One goal of the FTSC is to involve knowledge and expertise at U/WI-Madison in park issues and projects, and toward this end workshop participants made presentations open to the university community on the cultural, natural, and recreational resources of their parks and the issues facing them.

* * *

Regional Chief Scientist Ron Hiebert met with the Natural Resource Advisory Board for Haskell Indian National University Nov. 2-3 in Lawrence, KS, where the contributions of two NPS cooperative education enrollees and two interns from Haskell were recognized in an award ceremony.

* * *

Dr. Robert Brander retired from the NPS Nov. 12, 1993. At a farewell dinner in Washburn, WI, on Nov. 9, he was presented with the Dept. of the Interior Meritorious Service Award for major contributions in ecosystem management and inter-agency/ international cooperation. He will continue to work, as a re-employed annuitant, on special designations—a part of the Lake Superior Binational working group.

MAB Notes

The most significant recent event on the U.S. MAB front was the workshop held in December 1993 at Estes Park, CO, to develop a draft **Action Plan for the U.S. Biosphere Reserve Program.** Developed by 83 participants, including representatives from 33 biosphere reserves, the plan forms the basis for establishing an integrated U.S. BR program and constitutes a resource for ideas and actions that managers can use in carrying out their own BR objectives. It is a blueprint for moving biosphere reserve reality ever closer to the BR concept. The goals and some of the actions in the plan are the following:

• **Develop the organization and leadership to carry out the mission.** Actions include: Establishing a national BR Directorate with a budget; convening an annual meeting of the U.S. MAB Program; supporting selected BRs to become models for implementing BR concepts.

• **Develop political support and funding for the biosphere reserve program.** Actions include: U.S. MAB communicating with White House offices to include BRs in their policy and planning activities; establishing a challenge cost-sharing and/or competitive small grant program; convening a primarily private sector National Support Group; establishing a Non-governmental Biosphere Reserve Foundation.

• **Foster partnerships and community participation.** Actions include: Developing new, formal and informal communication tools; promoting the "cluster concept" of partnerships among conservation, research, and multiple-use areas; using formal agreements to establish partnerships.

• **Conserve and manage biosphere reserve resources.** Actions include: Exploring the feasibility of adding areas to existing BRs to implement fully the BR model.

• **Improve understanding of relationships between natural and human systems in biosphere reserves.** Actions include: Establishing standardized monitoring techniques; including demographic and socioeconomic conditions and the values, attitudes, and perceptions of local people in BR inventory and monitoring programs; identifying and improving access to commonly used databases.

• **Promote public awareness and education on the value and benefits of biosphere reserves.** Actions include: Developing and using public media to support the U.S. BR program; developing an aggressive marketing strategy for BRs aimed at potential governmental and private sector sources of funding and in-kind support; establishing a BR communications system based on a worldwide electronic network.

At its January 24 meeting, the U.S. MAB National Committee accepted the draft Action plan and directed the workshop drafting committee under Joann Roskoski and Bill Gregg to prepare a final draft for Executive Committee decision in March. The National Committee also committed to creating a Biosphere Reserve Directorate with representatives from BR managers, agencies with BRs, and stakeholders from the wider community. Internationally, a number of countries, including Australia, Canada, China, Germany, Mexico, and Spain, are reviewing their BR programs to see how improvement can be made.

Bill Gregg, former MAB Coordinator with the NPS, continues his deep involvement with MAB as chief of the international division of the National Biological Survey. Each agency in the MAB program will continue to have a MAB representative. That responsibility in the NPS will reside in the Natural Resource Directorate or some part of the directorate's reconfiguration in the Washington Office reorganization now underway.

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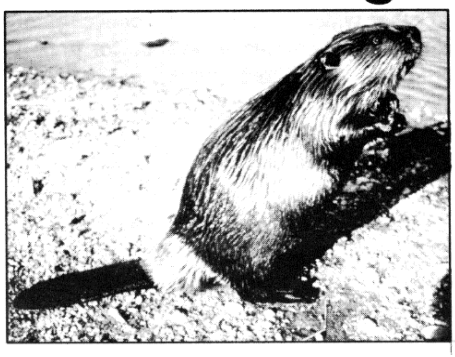
ISSN-0735-9462

Potential Beaver Recolonization at Indiana Dunes Being Evaluated by Means of GIS Analysis

By Eddie L. Childers



The beaver (*Castor canadensis*) originally inhabited much of the North American continent and was a valued resource for many settlers and native Americans. Northwest Indiana supported large beaver populations throughout the 1800s as noted by Kubik (1993). Beavers were extirpated thereafter, following loss of habitat due to wetland drainage operations and exploitation by settlers, native Americans, trappers, and hunter.

By the early 1900s, beavers existed only in the most remote and isolated areas of North America, and the original presettlement population of 60 million had been reduced to an estimated 100,000 animals. The beaver, that had become a symbol of a wilderness species, had been wiped out in areas inhabited by people.

Since the 1900s, Indiana and many other states have restored the beaver to much of its original range where suitable habitat still exists (USFWS 1987). Beaver restoration efforts in the U.S. began in the early 1900s, with releases of live trapped animals in New York, California, and Missouri. More live-trapped beavers were released in West Virginia, Michigan, and Wisconsin in the early 1940s.

Federal aid in the form of Wildlife Restoration Funds was made available through the Pittman-Robertson (P-R) Act. The P-R Act taxed the purchase of hunting equipment and provided the initial source of funding for beaver restoration throughout the U.S. P-R monies have provided over $2 billion toward wildlife restoration and recreational wildlife use. With the influx of P-R funding, live-trapped beavers continued to be released in unoccupied U.S. habitats, specifically Arkansas, Maine, Idaho, Wisconsin, Mississippi, Washington, Iowa, Pennsylvania, Massachusetts, Wyoming, Alabama, Louisiana, Colorado, and Indiana.

Beaver populations had made dramatic recoveries by the mid-1950s, and by the 1970s populations were estimated at 15 million nationwide. Beavers now are present throughout the U.S. and their numbers and range continue to grow. Suitable habitat that includes preferred food and water resources appears to be the key limiting factor to beaver recolonization.

Beaver population growth and dispersal is influence by land use, hydrology, food availability, and predation. Potential beaver recolonization within Indiana Dunes National Lakeshore (NL) will focus on areas that provide adequate food resources, cover, and surface water. For example, beavers recently have been observed along the Little Calumet River in the NL and have been known to travel into other areas of the NL as well. This article focuses on the probably effects of potential beaver recolonization in the East Unit of Indiana Dunes NL, using Geographic information Systems (GIS) with emphasis on beaver habitat suitability and potential carrying capacity.

The GIS analysis used the 68 previously classified plant communities of the NL's East Unit and reclassified them into the food habitat category types, based on known beaver food preferences (Martin et al. 1961) that included: Poplar-Aspen-Willow; Birch-Maple; Emergent Vegetation-Forested Fen-Wetland; Crops-Fields-Orchards-Grassland-Revegetation Communities; Dogwood-Cedar-Tamarack; Mesic Forest-Mesic Successional-Floodplain Scrub; Upland Forest-Upland Scrub-Sumac-Vines, and other habitat types (e.g. open water).

The vegetation community reclassification and the total area for each of the beaver food habitat types were generated for the East Unit using *r.reclass* and *r.report* (GRASS 4.0, 1991), respectively. National Lakeshore surface water and beaver food habitat categories also were analyzed to determine the amount of preferred beaver food habitat within 100 meters of surface water within the NL using *r.mask* and *r.buffer* (GRASS 4.0, 1991).

The GIS analysis investigated land use, surface water, and food availability to determine optimum beaver density and habitat for the NL. Potential beaver density, or carrying capacity, is expressed as number of colonies per km2. Beaver colonies usually are made up of 8 to 10 individuals. Beaver density values reported in the literature range from 0.38 to 0.76 colonies per km^2 by Voight et al. (1976) working in Algonquin Park, Ontario, and by Aleksiuk (1968) working in the Mackenzie Delta, Northwest Territory.

Total beaver food habitat potential for the NL's East Unit is estimated at 42 km^2 (Table 2). This amount of preferred food is capable of supporting more than 40 beaver colonies. If 100 meter wide buffer strips adjacent to NL surface water are considered exclusively in the analysis, total preferred habitat is approximately 14 km^2. Buffer strips this size probably correspond to primary beaver movement perpendicular to watershed.

This amount of habitat should support more than 20 active beaver colonies assuming this area represents the East Unit beaver carrying capacity. However, since trapping is not permitted and the coyote is the only known significant predator to inhabit the NL, a much lower number of active beaver colonies probably would be a more realistic threshold level for optimum beaver density at Indiana Dunes NL. This conclusion reflects the knowledge that beaver has been known to be a nuisance species in many areas of the U.S.

Recolonizing beaver in the NL's East Unit would provide many positive ecological benefits: Soil erosion control, ground water recharge, restoration of the Great Marsh to original presettlement hydrology, and creation of high grade waterfowl, furbearer, and aquatic species habitat.

Beaver populations also could expand to areas outside the park through emigration, thereby providing trapping opportunities to residents on private lands in northwestern Indiana. Resource Management staff will monitor beaver populations at the national lakeshore to determine if threshold levels are being exceeded, and will apply appropriate management actions as necessary.

Childers is GIS specialist at Indiana Dunes NL, Porter, IN 46304.

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Trail Conditions and Management Pr

By Jeffrey L. Marion

The author and colleagues Joe Roggenbuck and Bob Manning recently conducted a survey of NPS managers to describe visitor-related backcountry recreation management problems and practices. The survey and resulting NPS Natural Resources Report (available from Donna O'Leary—see references) address the following topics: (1) managers' perceptions of the types and severity of backcountry recreation management problems, (2) actions implemented to resolve problems, (3) managers' perceptions of the success of implemented actions, (4) managers' knowledge and application of carrying capacity models, and (5) the type and extent of monitoring efforts employed to assess impacts caused by recreational use.

Also available on request, is a computer diskette with dBASE III Plus databases containing information characterizing each park unit and the specific actions implemented to address backcountry recreation management problems. These databases are intended to facilitate communication of alternative backcountry recreation management practices. Instructions permit users to identify and list parks comparable to their own that employ specific backcountry recreation management actions. Contacts and phone numbers are included to facilitate dialog regarding implementation methods, administrative costs, supporting actions, effectiveness, and other factors which could not be characterized by the study.

This article presents selected results from the survey regarding manager's evaluations of trail resource conditions and the trail management actions they employ.

Management objectives for backcountry or natural zones call for the preservation of park resources and ecological processes in as natural a condition as possible. Visitor activities in these remote park areas tend to concentrate along trails, in scenic attraction areas, and on campsites. In particular, trails and trail networks play a significant role in shaping visitor access and distribution patterns in parks. Trails must support substantial traffic from both day and overnight visitors.

Trail impacts include a wide variety of problems, including loss of vegetation cover, incision and soil loss of the tread surface, widening of the tread, compaction of soil, proliferation of informal trails, and the results of various depreciative behaviors such as littering and cutting of trail switchbacks. Without proper trail maintenance programs these problems can alter natural patterns of water runoff, resulting in soil erosion and subsequent turbidity and deposition in streams and other water bodies. Trails concentrate visitation and provide an avenue for transportation. While some impact is unavoidable, excessive trail impacts threaten both the safety of trail users and the quality of their recreational experiences.

Study Methods

A mail-back questionnaire was sent to all NPS units judged to have substantial backcountry resources and overnight visitation. The park list was compiled from those parks specifically offering backcountry camping as described in *The National Parks: Camping Guide 1988-89*, and parks with significant backcountry overnight visitation reported to the NPS Socio-Economic Studies Office for the years 1986-90. Surveys were sent to park superintendents in September 1991 with a request that they be directed to park staff with responsibility for backcountry recreation management. The need for input from resource management staff was also noted. Compliance was high, with a return of 93 completed surveys for a 92 percent response rate. Additionally, 7 of the 8 non-responding parks were among the lowest in backcountry visitation. Completed surveys were input into dBASE III Plus databases and transferred to the SPSS-PC+ statistical package for analysis.

Results

NPS backcountry areas have a mean of 125 miles of official trail and 59 miles of unofficial trail (Table 1). However, these means reflect substantial trail systems in a few areas; for example, 9 parks had over 500 miles of official backcountry trails. The typical area (as reflected in median values) has 59 miles of official trails and 5 miles of unofficial trails. Interestingly, 17 percent of the backcountry areas in our survey had no officially recognized backcountry trails.

Table 1. Miles of official and unofficial backcountry trails.

Miles	Official Trails	Unofficial Trails
	Number of Parks	
0	15	17
1 - 25	22	23
26 - 50	13	5
51 - 100	16	3
101 - 250	10	3
251 - 500	3	1
Over 500	9	2

Official Trails: Mean = 125, Median = 35
Unofficial Trails: Mean = 59, Median = 5

Backcountry managers rated the perceived severity of 5 types of trail impacts using a problem severity scale based on the geographical extent of problems. Data from the two highest categories, "a problem in many areas" and "a problem in most areas" were combined, as presented in Table 2. Nearly one-half of all park managers reported that soil erosion on trails was a problem in many or most areas of the backcountry. Problems with trail widening was cited by 31 percent of parks, and 29 percent rated the formation of braided or multiple trails and the creation of undesired trails as serious problems.

Table 2. Managers' evaluation of the extent of backcountry trails impacts.

	Parks Where Impact is a Problem in Many or Most Areas	
	Number	Percent
Soil erosion	37	44
Trail widening	26	31
Braided or multiple treads	24	29
Creation of undesired trails	24	29
Excessive trail muddiness	21	25

The recreational activities that occur in backcountry areas vary in their environmental impacts to trail resources. backcountry managers were asked to indicate the extent to which they perceived day use, overnight use, recreation stock, off-road vehicles/all-terrain vehicles (ORVs/ATVs), and mountain bikes contributed to trail impacts. Three kinds of recreational use were predominant as causal agents for trail impacts: day use, horse use, and overnight use (Table 3). The percentages of parks citing these three uses as moderate or major causes were 47 percent, 43 percent, and 34 percent, respectively. Managers reported that day use is more common than overnight use in 70 percent of the backcountry areas and accounts for about 2/3 of all use. Also, while only 3 backcountry areas have more than 25 percent of their use made up by

Table 3. Managers' ratings of extent to which various recreation activities are a moderate or major cause of trail impacts.

Recreational Activities	Trail Impacts	
	Number	Percent
Day Use	39	47
Overnight Use	28	34
Horse Use	30	43
ORV/ATV Use	8	14
Mountain Bike Use	6	10

Table 4. Actions taken by park managers to reduce trail impacts parks taking the action.

Action	Number	Percent
Discourage off-trail travel	44	47
Encourage off-trail travel	10	11
Teach minimum-impact hiking techniques	32	34
Discourage use of unofficial trails	42	45
Discourage trail use during seasons when soils are saturated	19	20
Relocate trails from fragile to durable soils or vegetation types	38	41
Relocate trails to avoid steep grades	40	43
Perform regular general trail maintenance	48	52
Delineate trail edges to keep visitors on a defined tread	23	25
Close or rehabilitate impacted trails	27	29
Close or rehabilitate undesired trails	41	44
Install trail bog bridges or corduroy	28	30
Seed or transplant vegetation on trails	15	16
Apply trail soil cement	1	1
Gravel trails	13	14
Other: install hardening/boardwalks over sensitive areas	2	2

horse users, 43 percent of the parks see horse use as a moderate or major cause of trail impacts.

Managers have implemented a variety of actions to address backcountry trail management problems. A comprehensive list of potential actions was provided to managers, who were asked to indicate which actions were currently employed in all or some portion of their park's backcountry. Managers also had the option of listing additional actions. Trail maintenance, visitor communication/education, and trail closure were among the predominant actions used to address trail problems (Table 4). Surprisingly, managers reported that only 1/2 of all backcountry areas receive regular general trail maintenance.

Communication is used at nearly 1/2 of the parks to discourage visitors from travelling off-trail or using unofficial trails. These actions concentrate visitor use and trampling impacts on formally designated and maintained trails. In contrast, managers at 10 parks sought to minimize trail impacts through visitor dispersal by encouraging off-trail travel. Education to promote minimum impact hiking techniques was employed by managers at 1/3 of the parks and 1/5 reported that they discourage trail use during seasons when soils are saturated.

Trail relocation is used by 41 percent of the backcountry managers to shift trails from fragile to more durable soils or vegetation types. Undesired or user-created trails are actively closed and rehabilitated at 44 percent of the parks, a practice used by 29 percent of the parks for highly impacted trails.

As previously noted, horse users were perceived by managers to cause trail impacts out of proportion to their numbers. Managers reported that of the 60 areas that were open to horses, 55, (or 92%) prohibit horses within certain areas or on certain trails in the backcountry. Furthermore, 39 percent prohibited, and an additional 10 percent discouraged horse use from off-trail travel. Managers limit horse numbers at 1/2 of the areas open to horses; number of horses/group ranged from 0 to 50 with a mean of 12 and a median of 10.

Another survey section asked managers to list and rate the perceived effectiveness of specific actions implemented in response to common problems that had been effectively addressed. Most of the highly rated actions implemented to address trail impacts involved some form of trail work. Such actions included trail maintenance and rehabilitation, boardwalk installation, and delineation of trail treads. Some moderately effective actions included temporarily closing and relocating badly eroded trails, designation of trails for different uses, and promoting dispersed hiking. Backcountry managers generally rated visitor communication and education actions, such as signing of informal trails and promotion of low impact trail use, as somewhat effective.

Finally, managers were asked to list and describe monitoring efforts used to assess the effects of visitor use on the condition of trail resources. Trail impact monitoring was conducted at only 8 parks. Monitoring approaches included rapid assessment rating and measurement methods for documenting trail width and incision and research methods employing measurements of vegetation and soil loss. Trail inventory surveys designed primarily for assessing trail maintenance needs were conducted at 12 parks. These are typically conducted by maintenance division staff for the purpose of setting trail maintenance priorities and directing work. Informal evaluations of trail impacts and trail maintenance needs, typically conducted by field rangers during routine patrols, were used by 18 parks.

Summary and Implications

Of 8 types of backcountry recreation impacts evaluated, park managers perceived trail impacts to be the most severely pervasive problem. A surprising finding was that day users were perceived to be the most common type of backcountry visitor and that 47 percent of park managers cited day use as a predominant cause of trail impacts. Currently few parks attempt to measure day use and only 8 percent of the parks require permits for day users. Horse users, a relatively small percentage of the total use in most backcountry areas, also were perceived to be a predominant cause of trail impacts. Additional management and research attention is needed for these types of uses.

The most common and, according to managers, the most effective action employed to address trail impacts was trail maintenance. However, managers at only 1/2 of the parks indicated that routine trail maintenance was conducted in all or some portion of their backcountry. Additional resources and attention to professional and volunteer trail maintenance efforts are needed to address the serious and widespread nature of trail resource problems. Finally, a primary limitation of this survey was its reliance on manager's perceptions of resource problems and the effectiveness of implemented actions. Little objective data exists for any of the backcountry recreation management problems identified in the survey. For example, trail impact monitoring is conducted in only 9 percent of the parks. Additional monitoring is necessary to provide more objective information about changing resource conditions and the effectiveness of alternative management actions.

Marion is Unit Leader for the NPS/CPSU at VA Tech in Blacksburg.

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Marion, Jeffrey L., Joseph W. Roggenbuck, and Robert E. Manning. 1993. *Problems and practices in backcountry recreation management: A survey of National Park Service Managers.* USDI, National Park Service, Natural Resources Report NPS/NRVT/NRR-93/12. **Report available from:** Publications Coordinator, National Park Service, Natural Resources Publications Office, P.O. Box 25287, Denver, CO 80225-0287.

Information Crossfile

For a mystery story as fascinating as any by Agatha Christie, read the News and Comment section of ***Science***, Nov. 5, 1993, pp 832-51. Extended coverage about the hantavirus outbreak in the southwestern U.S. includes several "side-bar" stories about deer mice and pinon nuts, "virology without a virus," a "rogues' gallery of hantaviruses," and how the whole lethal mystery was unraveled through a combination of luck, serendipity, alert scientists, and the polymerase chain reaction (PCR)—which amplifies viral genes from victims' tissue.

Researchers are still furiously in pursuit of a successful culturing of the hantavirus that caused the death of at least 26 people in the U.S. in 1993. They have its genes, they know where it hides, and they are desperately working to discover its modus operandi. One virologist and longtime hantavirus hunter in the National Institutes of Health lab is convinced that the hantaviruses are endemic in the U.S. and may have been causing disease for some time now. Even in the absence of a cultured virus, the PCR method has firmly established the identity of this virus, and deer mice appear to be the major carriers.

* * *

The biggest news may not be the creation of a stunning 560,000 acre provincial park in the Coast Range 150 miles north of Vancouver, B.C. Glorious as is Ts'yl-os Park, centered on 30-mile-long Chilko Lake, spawning area of an internationally valuable salmon run, the headline worthiness of this event may lie in the task force that put together the park proposal. Its membership ranged from the International Woodworkers of America to the Federation of BC Naturalists. "It shows that as long as people are willing to sit down and give a little, you can reach agreement," said Bill Derbyshire of the woodworkers union.

The provincial government is pledged also to work with the nearby Nemiah Valley Indian Band in managing the park, which is named for the mountain above the lake—a mountain said to hold spiritual significance for the Indians who live in this isolated, undeveloped area.

Dr. Tom Perry, a provincial legislator who has explored the area, calls it "one of the most glorious in North America if not the world. Nothing I've seen in Nepal beats it, and it easily matches the finest scenery in the Andes."

* * *

"Grim" is the word that many headline writers in the nation's press used to describe the contents of the new edition of ***State of the World***, published Jan. 15, 1994 by Worldwatch Institute. The projection that justified the adjective was the serious slowdown in the growth of food production, on land and in the seas, at the same time the global population is growing "by leaps and bounds." Compared to the average increment of 70 million persons a year between 1950 and 1990, the next 40 years are projected to see an average annual increase of 90 million. Growth in the oceans' fish catch came to a halt in 1989. When you add the loss of momentum in grainland growth in the U.S. and Europe and the even more pronounced slowdown in the rise of Asia's rice yields, the balance between food and people "now depends more on family planners than on farmers," according to the report.

* * *

Areas of Africa rich in different species of plants and animals are described by Derek Pomeroy of Makerere University in Kampala, Uganda in the December 1993 issue of ***Conservation Biology***. "In the case of plants, the countries with the highest relative species richness are, in order, South Africa, Tanzania, Cameroon, Gabon, and Swaziland," he writes. In the case of mammals, it's Uganda, Togo, Kenya, Cameroon, and Zaire. Zaire heads the list for butterflies. Nonaquatic bird species tend to concentrate in the vicinity of Mt. Cameroon, the East African Highlands, and parts of Angola. Waterbirds flock to much of eastern Africa. Pomeroy reports that South Africa has probably the highest concentration of species of flowering plants in the world but only a handful of endemic birds.

* * *

St. Lucie Press has produced a new reference, ***The Everglades Handbook***, by Thomas E. Lodge, that contains a wealth of information on the entire ecosystem—upstream and down. Starting with a Marjorie Stoneman Douglas introduction, the book describes the region's geology and geography, plant communities and animal groups and their interrelationships and functional roles within the system, the impact of hurricanes, and the effect of humans on the Everglades environment. The 200 page, illustrated, 6x9 softcover (ISBN 1-884015-05-0) volume is available for $29.95 from St. Lucie Press, 100 E. Linton Blvd., Ste. 403B, Delray Beach, FL 33483.

* * *

"Isolation of Remaining Populations of the Native Frog, *Rana muscosa*, by Introduced Fishes in Sequoia and Kings Canyon NPs," co-authored by David M. Graber, appeared in the December 1993 issue of ***Conservation Biology*** (Vol. 7, No. 4, pp. 882-888). *Rana muscosa*, (the mountain yellow-legged frog), was eliminated by introduced fishes early in this century in many of the lakes and streams in Sequoia and Kings Canyon NPs. In waters not inhabited by fish, *R. muscosa* also has disappeared at many sites in the past 30 years and it appears to have gone extinct in some drainage. The authors conclude that fragmentation of populations may have caused or contributed to these recent extinctions, because *R. muscosa* populations are significantly more isolated from one another by fish at present than in prestocking conditions.

Graber is a research scientist at Sequoia/Kings Canyon NPs.

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The President's Council on Sustainable Development (PCSD), established by President Clinton in June 1993, held its first meeting outside of Washington, D.C. on Jan. 13-14, 1994 in Seattle, WA. The goal of the PCSD is to explore and develop policies that encourage economic development, job creation, and protection of natural resources. The Council is comprised of 25 high-ranking officials from industry, government, environmental groups, labor, and civil rights organizations, and is co-chaired by Jonathan Lash, President of the World Resources Institute, and David Buzzelli, Vice President of Dow Chemical Company.

The Council meets quarterly during the initial 2-year period and can be renewed by President Clinton for 2 more years. Its members serve on 6 task forces: (1) Defining principles of sustainable development; (2) Setting public dialogue and education activities in motion; (3) Redefining national energy policies; (4) Identifying models of sustainable manufacturing, pollution prevention, and other eco-efficient strategies; (5) Establishing guidelines to expand natural resource protection and management; and (6) Identifying examples and elements of sustainable communities.

Molly Olson is Executive Director of the Office of Sustainable Development, at Mailstop 7456, 1849 C St., N.W., Washington, DC 20240; (202)208-7411.

* * *

The Feb. 1, 1994 briefing paper from NPS Director Kennedy on Strengthening and Streamlining the National Park Service contains news of special interest to the field: "...the NPS will be delegating considerably more responsibility and authority tothe parks and field-level programs, reducing layers of

management and review, and consolidating the remaining support functions in a smaller number of central offices. The goals of this reorganization are to allocate people and money toward park and project management, to the extent possible, in order to facilitate decisive, timely action to protect the natural and cultural resources that define our character as a nation and to make that heritage accessible to as many people as possible."

Together with downsizing and upgrading efforts, the Director described "an intensive effort to recruit, retrain, and retain a highly professional and diverse cadre of people capable of understanding the complexities of managing America's heritage resources as parts of whole systems and skilled in working with others, both inside and outside government." The intention, he stated, "is to strengthen the Service and protect the Parks."

* * *

Gary Sullivan of the NPS Midwest Region writes to call *Park Science* readers' attention to an article in ***Science***, December 1993, pp. 1514-15, suggesting that the disappearance of songbirds is a result of loss of woodland nesting habitats and tropical wintering grounds as well as cowbird depredation, and that such depredation should be looked at carefully before action against cowbirds is taken. The account downgrades the cowbird problem from a continental scourge to a regional problem, with California and the upper Midwest as areas of greatest concern.

In the next issue...

- "Neotropical Migratory Bird Workshop and Research" by Ralph Grundel and Theodore R. Simons.
- "Long-term Monitoring on a Shoestring at Apostle Islands" by Julie Van Stappen.
- A review of James K. Agee's *Fire Ecology of Pacific Northwest Forests* by Dave Perry, Oregon State University professor of ecosystem studies.
- "Animal Disease Issues in the National Park System" by Alonso Aguirre and Ed Starkey.
- "The Other Side of Gap Analysis" by Kathy Jope.
- A report on the Interagency Wolf Management Steering Committee's nationwide recovery plan (if those plans have jelled by press time).
- "Social Science Studies at Great Basin NP: What Do They Tell Us?" by Perry Brown and Marty Lee.
- "Reconstructing Climate Data in Parallel Watersheds" by Robyn Myers.

Working with Williams in WASO

By Sarah Allen

In July 1993, I began working in the Western Regional Office with two primary duties: coordinating both the biological inventory and monitoring program and the threatened and endangered species program. I am not only new to the Western Region, but also to the Park Service. I have studied in and around parks for the past 18 years, but this hardly prepared me for the labyrinth of places, people, forms and procedures.

The trip to WASO was by invitation from Dr. Gary Williams, Manager for the Inventory & Monitoring (I&M) Program. Gary had a check list, at least up to my elbow, of various tasks from which I could select. I chose defining and fleshing out the duties of the I&M regional coordinator. My primary reason for being in WASO, though, was to meet the staff with whom I have, and will have, working relations.

I arrived at Dulles airport with many preconceptions. The first was that temperatures are arctic in mid-November on the east coast. When I departed from home near San Francisco early Sunday morning, I had had to scrape ice off the car window, but when I arrived in Dulles that evening, temperatures were warm and due to be still warmer the next day. A second fallacy was that Washington was a swollen and sluggish bureaucracy. Instead I was greeted by a devoted, bustling staff with little time for small talk. I have seen this motivation throughout the Park Service —the ability to do a lot with very little. People work long hours with short breaks and come in on weekends. One down side, though, is that I found little opportunity to socialize with staff; I would have delighted in relaxed conversations outside of the office where we could escape interruptions from phones and people. Rather than leave the overtures to WASO staff, I would encourage any new visitor to take the initiative and corner a hapless victim for lunch or a walk to the Smithsonian.

The Washington Office actually is two offices; the main offices of Interior are on C Street; the Vegetation and Wildlife group is a few miles away near the Capital building. A shuttle service cycles between the two offices several times each day. This convenience was particularly appreciated because I had been warned that walking around the Capital can be a dangerous exercise. Everyone, from hotel clerks to taxis drivers, exhorted me not to venture out after dark. One evening, though, I found a bevy of labor union protesters marching to a rally on the Hill, so I joined them for protection and a bit of sightseeing.

I had never before been in Washington, so I spent some time orienting to the city and locating offices and personnel. This pastime proved very rewarding. All whom I approached were more than willing to interrupt their tasks to help orient a newcomer. This was particularly true at the NPS Vegetation and Wildlife office, where I spoke with all who were not out of town.

I also made an effort to get out for lunch and stroll around the Capital to visit monuments such as the Lincoln and Vietnam War Memorials. The grounds around the monuments were very clean, with little trash or graffiti, and I reflected with some pride that NPS personnel were responsible for the pristine appearance of the grounds—a condition that added significantly to the overall visual and aesthetic impression.

Several points may be helpful to the new arrival to WASO. Foremost, find out in advance what sort of office accommodations will be available to you including space, phone and computer access. Gary Williams provided a small, neat desk from which to work, and I was fortunate when a staff member who was going to be absent for a week kindly offered use of her office. Being fairly picky about computer programs, I brought my own lap-top machine. An additional benefit was few phone interruptions since I was away from home duties. Having all the tools of my home office and privacy too increased my productivity and signficantly shortened the "settling in" process. Rose, the secretary, was especially attentive. She made sure I was comfortable, knew where to find things (such as the FAX) and had all needed supplies.

Finally, a week is the minimum time for a Washington stint, and a longer stay is better. I was just becoming comfortable with the ways of WASO when my visit was over.

Gary Williams has just issued a call to all Regions offering an opportunity to visit WASO on detail to work in the I&M Program. He proffers several tasks to attract participants. Now is your chance!

Sarah Allen is a Natural Resource Specialist in NPS Western Region

Ash Yellows and Defoliating Insects Related to Decline of Velvet Ash in Zion National Park

By Wayne A. Sinclair, Helen M. Griffiths, Michael Treshow, and Robert E. Davis

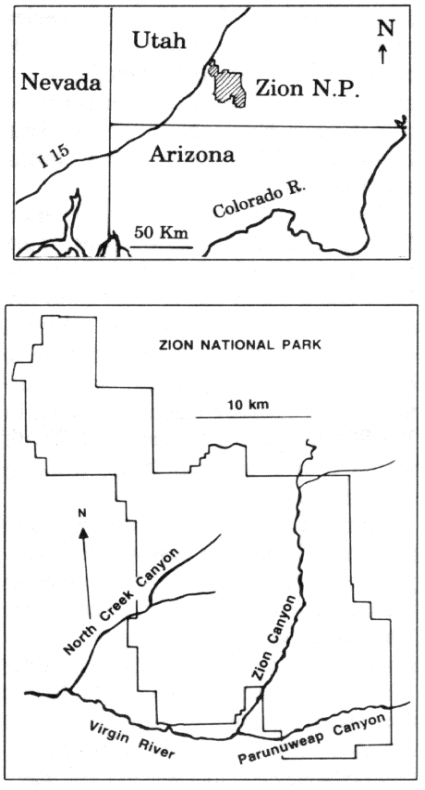
Zion National Park, on the southwestern flank of the Markagunt Plateau in southwestern Utah (Fig. 1), encompasses habitats ranging from arid to wet (Hamilton 1984). Velvet ash (*Fraxinus velutina*) colonizes moist sites in canyons there. In the late 1980s, a syndrome of slow growth and branch dieback was noticed affecting many velvet ash in Zion Canyon. The symptoms resembled those of a disease, ash yellows, that affects ash species in eastern and midwestern states (Matteoni and Sinclair 1985). Ash yellows is caused by noncultivable mycoplasmalike organisms, or MLOs.

MLOs are prokaryotic obligate parasites of plants and of the insects that serve as their vectors. MLOs belong to the class Mollicutes and cause several hundred plant diseases (Lee and Davis 1992). Within plants, MLOs colonize plants systemically by way of phloem sieve tubes and are confined to this cell type. Because MLOs can not yet be isolated and cultured apart from plant or insect hosts, they have not been named or classified at generic and species levels. The term *mycoplasmalike organism* connotes resemblance to mycoplasmas, a number of which are significant pathogens of birds and mammals (Maniloff et al 1992).

In northeastern states, ash yellows causes rootlet necrosis, growth loss, and dieback of white ash (*F. americana*) (Dyer and Sinclair 1991; Matteoni and Sinclair 1985; Sinclair et al 1990, 1993b; Smallidge et al 1991). Growth suppression also occurs in MLO-infected green ash (*F. pennsylvanica*) (Sinclair et al 1993b), but dieback in this species is not closely linked to yellows disease (Luley et al 1992). Witches'-brooms (Fig. 2a) are diagnostic for ash yellows, but only a minority of trees with the disease produce them.

MLOs were detected in velvet ash in Zion NP in 1988 (Sinclair et al 1990). Slow growth, dieback, and occasional witches'-brooms were noted. It seemed likely that velvet ash was displaying an MLO-induced syndrome similar to that described for white ash. The research summarized here (Sinclair et al 1993a, 1993b; 1994) began in 1990 to learn the distribution and incidence of declining velvet ash and of ash yellows within Zion NP, to evaluate the relationship between MLO infection and health of this species, and to learn whether or not singleleaf ash (*F. anomala*) in Zion NP is also affected by MLOs.

Figure 1. Location of Zion National Park and its principal canyons.

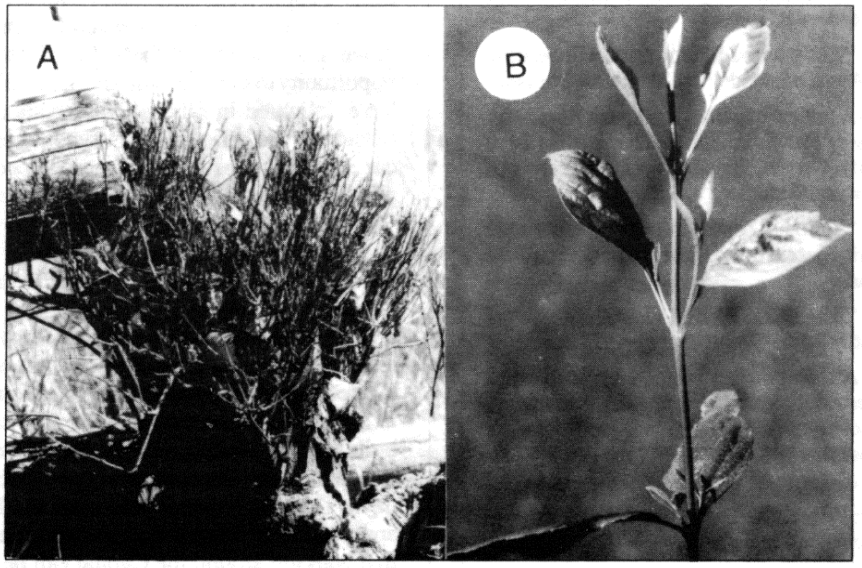


Methods

Velvet ash in the three largest canyons of the park (Fig. 1) were surveyed for health status and incidence of MLO infection. In Zion Canyon, ash on 17 plots were scored for degree of vigor and severity of dieback. The trees were also examined for evidence of injury by insects and for symptoms associated with ash yellows: witches'-brooms, sprouts on the butt or bole, simple leaves on sprouts, deliquescent branching, and chlorosis (Matteoni and Sinclair 1985). The condition of tree species associated with velvet ash was noted. Soil and other site conditions were recorded. Root samples for diagnostic testing by means of the DAPI (4',6-diamidino-2-phenylindole.2HCl) fluorescence method (Sinclair et al 1989) were taken from 382 velvet ash trees and saplings and from 53 singleleaf ash. This method permits detection of microorganisms in phloem sieve tubes based on fluorescence of their DNA when sections treated with DAPI are examined microscopically with UV illumination.

Relationships between vigor scores and diagnostic data were evaluated by means of contingency analyses that tested whether frequencies of symptoms observed in MLO-infected trees could differ from the corresponding frequencies in noninfected trees due to chance. These tests were performed

Figure. 2. A. Witches'-broom on an MLO-infected stump of a velvet ash felled by a beaver. **B.** Velvet ash shoot from a cluster growing at the base of a dying, MLO-infected tree, showing simple leaves and precocious axillary shoots. These symptoms were seen only on MLO-infected trees.



separately for trees 6 cm dbh and for saplings < 6 cm dbh. Growth of velvet ash as related to MLO infection was assessed by measuring widths of growth rings on increment cores and comparing average annual growth rates of MLO-infected and noninfected trees. The susceptibility of velvet ash to MLOs from white ash, and of white ash to MLOs from velvet ash was assessed by grafting potted trees of each species with bark patches or shoots from diseased trees of the other species. Grafted trees were then tested for infection and observed for symptoms.

MLOs in velvet ash in Zion Canyon were identified as ash yellows MLOs by three procedures: DNA hybridization tests utilizing cloned ash-yellows-specific probes derived from a New York strain of ash yellows MLO (Davis et al 1992), amplification of MLO DNA by a polymerase chain reaction (PCR) utilizing ash-yellows-specific primers derived from one of the DNA probes, and immunofluorescence microscopy utilizing an ash-yellows-specific monoclonal antibody (Griffiths et al 1994).

Results and Discussion

Slow growth, branch dieback, and deliquescent branching were the most prominent symptoms of distress in velvet ash. Trees of all sizes greater than approximately 6 cm dbh were affected, and they occurred on diverse sites. Foliar color was generally normal. Except for an occasional irrigated specimen, vigorous trees were confined to the sapling category. Water shortage associated with changed site conditions but not with precipitation deficiency apparently contributed to decline of some trees, because declining or dead specimens were found in a number of dry locations that were formerly irrigated or became isolated from the river. Records from the Zion NP meteorological station revealed no unusual precipitation deficiency during the 1980s, when much of the dieback apparently developed.

Symptoms diagnostic for ash yellows were uncommon. These symptoms included witches'-brooms near or at ground level (Fig. 2a) and shoots with simple leaves and precocious secondary shoots in leaf axils (Fig. 2b) within brooms or growing from the root collar.

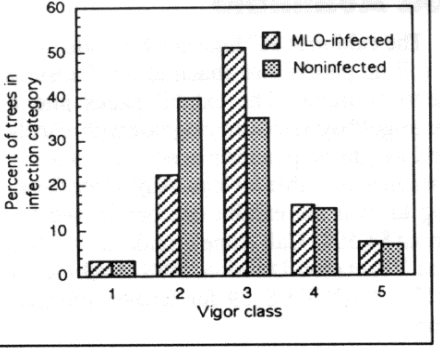
Damage by defoliating insects was prominent on velvet ash, box elder (*Acer negundo*) and Fremont cottonwood (*Populus fremontii*). Severity of defoliation ranged from none to complete, even among individuals in the same stand. The insects responsible were unidentified loopers (*Lepidoptera: Geometridae*). Slow twig growth and dieback of twigs and branches occurred on ash and box elder on which severe defoliation was previously observed. Many velvet ash also sustained severe foliar injury by ash plant bugs (*Tropidosteptes pacificus*) or lace bugs (*Leptophya* sp.). The former insect caused stunting and sometimes death of developing leaves and shoots and stippling on expanded leaves. The latter insect caused stippling and general yellowing of mature foliage in summer.

MLO infection was detected in velvet ash all three canyons surveyed. In Zion Canyon, 50 percent of 243 trees 6 cm dbh and 35 percent of 139 saplings tested were found to be infected. In North Creek and Parunuweap canyons, MLOs were detected in only 5 percent and 7 percent, respectively, of the 70 and 79 velvet ash tested. The high incidence of MLO infection in velvet ash in Zion Canyon was thought to reflect a more suitable habitat for vector insects (presumed to be leafhoppers) than occurs in the other two canyons. MLO infection was not detected in singleleaf ash. DNA hybridization and immunofluorescence tests both indicated close relatedness of MLOs in velvet ash in Zion NP to those in other ash species in eastern states (Griffiths et al 1994).

Velvet ash saplings infected with MLOs were found in all three canyons, indicating that young plants are at risk of infection, that overland spread of the MLOs by airborne vectors has probably occurred, and that incidence of infection may have been increasing in Zion NP in recent years. Possibly ash yellows is widespread in the Southwest, because MLO-infected Modesto ash, a variety of velvet ash, have been found in Las Vegas, NV (Sinclair et al 1990) and Tempe, AZ (Bricker and Stutz 1992).

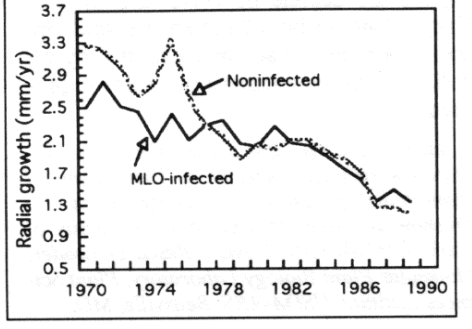
The frequency of MLO infection varied among vigor categories of trees larger than saplings in Zion Canyon (Fig. 3). Dieback was observed in 74 percent of trees in which MLOs were detected, versus 56 percent of trees tallied as not infected. This difference was greater than could be accounted for on the basis of chance. Moreover, the frequencies of various vigor scores of MLO-infected ash did not fit the ratio that would be predicted from the distribution of vigor scores of noninfected trees. These results were in accord with the interpretation that MLOs play a role in the decline of velvet ash in Zion Canyon. In velvet ash saplings, however, no significant association of MLO infection with dieback was detected.

Figure. 3. Distribution of vigor classes among MLO-infected and noninfected velvet ash 6 cm dbh in Zion Canyon. Classes: 1 = normal in appearance and vigor, 2 = growing slowly and/or having a thin canopy, 3 = growing slowly and having a thin canopy and dieback of twigs and/or scattered branches, 4 = dieback of many branches or large limbs, 5 = dead to near ground level.



Annual radial growth of velvet ash in Zion Canyon was found to have declined steadily during the 1980s, but trees in which MLOs were detected in 1990-1992 displayed the same growth trend and grew at nearly the same average rate as those in which MLOs were not detected (Fig. 4). In the northern half of the canyon, where defoliation was most conspicuous in each year of the study, radial growth averaged less than 1 mm per year throughout the 1980s (Sinclair et al 1993b). Previous episodes of defoliation may have caused the observed slow growth and dieback. No differences in growth or form were detected between MLO-infected and noninfected saplings that were observed for 3 years.

Figure 4. Annual mean radial growth of MLO-infected and noninfected velvet ash in 1970-1989. Data represent measurements on two increment cores from each of 38 infected and 19 noninfected trees in Zion Canyon.



A New York strain of ash yellows MLO was transmitted by grafts from white ash into velvet ash and white ash seedlings. The latter species provided susceptible standards for comparison with velvet ash. MLO-infected velvet ash continued vigorous growth, while MLO-infected white ash developed rootlet necrosis and grew feebly. MLOs were transmitted from velvet ash growing in Zion Canyon to only one white ash seedling out of 25 grafted. This seedling developed rootlet necrosis and died.

Continued on page 22

Ash Yellows continued from page 21

The findings of only a weak association of dieback with MLO infection, no difference in growth rate of MLO-infected and noninfected trees in Zion Canyon, and vigorous growth of young velvet ash inoculated with an eastern strain of ash yellows MLOs all indicated that velvet ash is tolerant of infection by these organisms. Perhaps MLOs affect the health of velvet ash only to the extent that infected trees may be more sensitive to, or may recover from, other stresses (e.g., defoliation, water shortage) less fully or rapidly than noninfected trees, as Han et al (1991) suggested for white ash. Or perhaps AshY MLOs are widespread and innocuous in healthy-appearing as well as debilitated velvet ash but have been detected only where declining trees were studied.

The role of MLOs in decline of velvet ash in Zion Canyon is apparently small. On the other hand, the decline of mature individuals of this species is conspicuous. This decline may have been caused primarily by defoliation by insects, with water shortage playing a role for some trees. The question for resource managers is whether measures to arrest or reverse the decline of velvet ash in Zion Canyon should be attempted. Feasible options for remedial action are limited by the policy of allowing natural processes to proceed.

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Acknowledgments

This research was supported in part by NPS through contract CA-1463-5-0001. We thank Larry Hays, Darla Sidles, and Victor Vieira of the Resource Management Unit, Zion NP, for facilitating the work.

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Research Exhibit Available

NPS science, resource management, and interpretive staff should be aware that an exhibit inviting scientists to do research in national parks is available for use at conferences and elsewhere. The exhibit states reasons for choosing parks as research sites, shows examples of research done in parks, describes needed types of research, and has an attached holder with information sheets listing regional office contacts.

The exhibit is 88" high and 80"wide, with 3 roll-up panels that attach to a collapsible network frame. The exhibit packs into a large-golfbag-sized carrying case with wheels and weighs 68 pounds loaded. The existing exhibit is available for loan. Any office desiring to own the exhibit can obtain one for about $4,500. Call Anne Frondorf, Wildlife and Vegetation Division, NPS Washington Office (202)343-8129 for further information.

Partnerships: NBS and the States

The National Biological Survey and the States have similar missions when it comes to distributing biological information.

On Nov. 11, 1993, the NBS was established to gather, analyze, and disseminate the biological information necessary for the sound stewardship of the Nation's natural resources, and to foster understanding of biological systems and the benefits they provide to society.

State governments are major collectors and managers of biological information and are major natural resource decision makers in their own right. Consequently, the NBS is constantly developing working arrangements for biological data sharing. NBS is encouraging positive scientific relationships with each state, to allow for increased access and integration of biological information. NBS will be a facilitator, and will work with states to form partnerships for research projects and data sharing.

To date, NBS staff have begun discussions with several states to determine their interest in initiating such efforts. A nationwide analysis is being prepared that evaluates state capabilities and identifies existing NBS operations that would form a strong initial basis for cooperation with NBS.

Discussions regarding state interest, capabilities, and sensitivities also are ongoing with the International Association of Fish and Wildlife Agencies, the National Association of State Foresters, and the Wildlife Management Institute.

The goal of these efforts is to develop the capability, at the state level, for increased access and integration of biological information. Meeting this objective will require increased cooperation in the identification and delivery of information held by federal agencies and others. A key component of early NBS activity in these state partnerships is working with state and federal agencies to identify available information, and to ensure that users of this information are aware of and have access to the information.

The NBS mission includes performing research in support of biological resource management; inventorying, monitoring, and reporting on the status and trends of the Nation's biotic resources; and developing the ability and resources to transfer the information gained to resource managers and others concerned with the care, use, and conservation of the Nation's natural resources.

Bu Eugene Hester
Deputy Director, National Biological Survey

Study Documents Mountain Goat Impacts at Olympic National Park

By E. Schreiner and A. Woodward

Approximately 12 mountain goats were deliberately introduced to the Olympic Mountains in the 1920s; the animals subsequently spread throughout the Olympic Range. Olympic National Park was created in 1938. Although mountain goats are native to the nearby Cascade Mountain Range, historical, archaeological, and anthropological evidence indicates they were absent historically from the Olympic Peninsula. The estimated Peninsula-wide mountain goat population was 550 to 800 in 1980, 1,175 plus or minus 171 (standard error) in 1983, and 389 plus or minus 106 (SE) in 1990. Several hundred animals were removed from Olympic NP between 1981 and 1989.

The mountain goat is a generalist herbivore, strongly associated with cliffs and rock outcrops (Chadwick 1983). Its food habits vary considrably among populations because of this association. Diets apparently are dictated more by whatever plant species are present than by a preference for any particular species or growth form.

Seasonal Distribution

In the Olympics, mountain goats are seasonally migratory and are distributed in "nodes" or subpopulations. Subalpine and alpine areas above 5,000 feet generally are considered to be summer range, but even on hot summer days animals sometimes are found as low as 2,000 feet. Goats generally winter on steep south and southeast facing outcrops and cliffs below 5,000 feet, and may be found down to 1,000 feet. Our studies were conducted in mountain goat summer range, which we defined as the region above 5,000 feet.

Previous studies of the interactions between mountain goats and their summer range in Olympic NP clearly demonstrated that goats changed native ecosystems. Plant community effects included reduced moss and lichen cover, increased exposure of mineral soil from wallowing and trampling, and rearrangement of plant species dominance relationships in favor of ruderal species (plants found mainly in disturbed areas, so-called disturbance-oriented species). In addition, three Olympic Peninsula and one Olympic Peninsula/Vancouver Island endemic plant taxa were consumed by goats (these are "narrow" endemics—they are found on the Olympic Peninsula or the Olympic Peninsula and Vancouver Island, but nowhere else in the world).

Even though the aforementioned studies demonstrated that goats substantially altered native plant communities, additional investigations were required to extend the evaluation in space and time. Previous studies were conducted chiefly in one area of the park over a four-year period. Consequently, a series of investigations was begun in 1981 to expand our understanding of mountain goat/vegetation and soil interactions. Objectives were to describe plant communities and large herbivore sign in mountain goat summer range (5,000 ft) and to test the following two general null hypotheses:

(1) Reducing mountain goat densities will not result in changes to the relative abundance of plant species (i.e. plant community structure).

(2) Mountain goats pose no threat to the long-term persistence of rare plants.

Methodology Employed

We employed a variety of independent study methods from 1981-1992 to achieve these objectives:

(1) Extensive surveys of vegetation and herbivore use were conducted in high, medium, and low goat density areas within the 107,490 acres of land free of glacial ice above 5,000 feet;

(2) Permanent plots were established in three areas to quantify plant community responses to intentional reductions in goat density. (This is a unique aspect of our study — goat density was reduced intentionally through live capture concurrently with our permanent plot studies in areas with vastly different climates; thus we did not have to rely on exclosures as a means of evaluating the effects of herbivores);

(3) Potential effects of goats on the long-term persistence of rare plants were assessed using data on rare plant geography and abundance;

(4) The demography and autecology of a particularly rare endemic taxon (Olympic Mtn. milkvetch—we estimate the total population as about 4,500 plants) was investigated; and

(5) A series of historical photographs was used to examine qualitatively the vegetation changes over a 70-year period, specifically addressing the relationships among climate, human use, natural disturbance, and mountain goats.

In common with all other studies of ungulate grazing systems, our work demonstrated that introduced mountain goats have indirect and direct effects on the vegetation of the Olympic Mountains. We have no reason to believe that the overall biotic effects of goats on Olympics vegetation differs appreciably from mountain goat grazing systems where the animals are native. Nonetheless, changes in the park's vegetation due to goat activity have been substantial, and the status of rare plant populations in goat habitat is of concern.

Plant Community Changes

Mountain goats modified the structure of subalpine plant communities of the Olympics. Following the reduction in goat density, ruderal species such as yarrow decreased while selected goat forage species such as Idaho fescue increased at Klahhane Ridge (estimated annual precipitation, 40-60"). Yarrow cover exceeded that of fescue when goat density was high; it was less than fescue by the end of the study.

We believe mountain goats changed the nature of the competitive relationship between these two species, particularly since a laboratory study demonstrated that Idaho fescue was the stronger competitor except when clipped (del Moral 1985). Similar changes in plant cover of these two species were observed in comparative photographs in exclosure studies (Pfitsch and Bliss 1985).

Modifications of plant communities also occurred in another area of the park. Mount Dana (estimated annual precipitation 200+ inches) plots exhibited statistically significant changes in the plant cover of selected and non-selected plant species, but no change in dominance. Percent cover of dominant, strongly competitive species such as showy sedge appeared not to respond to lower goat density. This does not necessarily mean that the sedge was unaffected by goats. This highly productive species is consumed by goats and may compensate for loss of grazed plant tissues. Graminoid species are well-known for compensatory response to grazing.

Mountain goats also influenced the Olympic ecosystems by wallowing and trampling. Wallows disturb soils and create mineral substrates for colonization by plants. Studies of Klahhane Ridge goat wallows (and bison wallows elsewhere) have shown that disturbance-oriented plant species dominate wallow edges and that this community differs from surrounding vegetation.

Presence of Wallows

We did not examine vegetation surrounding goat wallows, but did document the presence of wallows. There are fewer in areas of low goat density, but at least one wallow was found in each of the 22 areas examined across

Continued on page 24

the park. We suspect that the disturbance-liking species have invaded these wallow edges as they have on Klahhane Ridge. Such a result would not be unexpected because Olympic subalpine and alpine plant communities are particularly sensitive to soil disturbance. Moreover, some scientists believe that physical disturbances associated with herbivory may be even more important than grazing as an ecosystem shaping process.

Incidentally consumed forage species may suffer intensive grazing at either high or low herbivore densities (Futayama and Wasserman 1980 and Houston 1982). These forage species may be eliminated because they exert no feedback control on herbivore population size. In a hypothetical one-herbivore/one-plant species system, the eminent biologist Graeme Caughley noted that the herbivore and plant must reach a dynamic equilibrium or the herbivore goes extinct (Caughley 1982).

Further, in a one-herbivore/two-plant system (assuming the two plant populations have different growth rates), "The extinction of one of the two plants is a direct consequence of its sharing the area with the other…It goes extinct when sharing the area because the herbivore numbers and hence the grazing pressure is maintained at a higher level than would be possible if the slower growing plant were the only food available." (Caughley 1982:311).

Thus, rare plants may be at risk from mountain goats for at least two reasons: (1) Mountain goat population densities likely are not controlled by plant abundance on summer ranges (Houston and Stevens 1988), let alone rare plant abundance, and (2) goats are generalist herbivores with the capacity to consume most plant species, including rare plants.

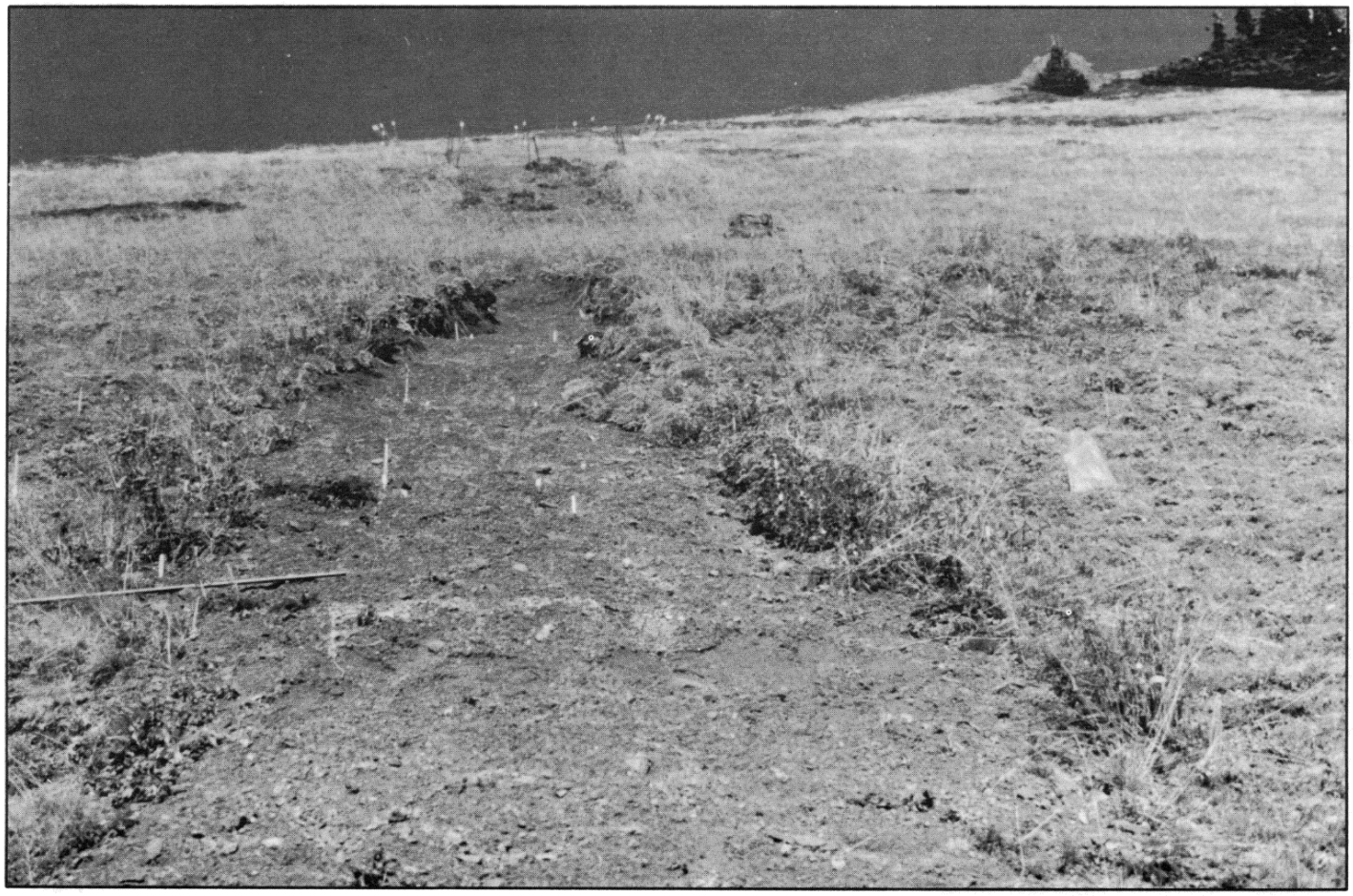
Long-term Concerns

We remain concerned about the long-term persistence of rare plants in mountain goat habitat. Direct effects were observed as mortality and injuries to individuals of the endemic Olympic Mountain milkvetch. One other endemic, Olympic aster, was a plant "selected" by goats. We also found that rare plant distributions (33 taxa), including 7 of 8 endemic taxa, overlap goat summer range. We note that *the effects of goats on individual plant taxa may be severe* or potentially severe, especially for taxa with very restricted distributions (i.e. those that occur in fewer than 5 subpopulations). Rare endemic plants have been driven to extinction or near extinction elsewhere by introduced herbivores (e.g. goats in Hawaii, Galapagos Islands).

Plant/herbivore grazing systems have been the subject of intense study by ecologists during the last two decades. Herbivores have been shown to affect numerous attributes of vegetation including plant morphology, species composition, abundance, net primary productivity, and the genetic makeup of plant populations. The scale of plant/herbivore interactions ranges from effects on individual plants to whole ecosystems. Effects of herbivores have been documented in long-established natural ecosystems such as Olympic NP (elk), Wind Caves NP (bison and prairie dogs), and the Serengeti plants of Africa (wildebeest and others). Also chronicled are the consequences of recently introduced wild ungulates (Himalayan thar in New Zealand and red deer in the Falkland Islands).

Characteristically, ungulates and vegetation are linked by strong feedback loops between the dynamics of the plants and the dynamics of the animals. Where ungulate populations are limited by available food

(PHOTO BY J. HARTER, OCTOBER 20, 1981)



resources, as their populations increase, available per capita resources (i.e. palatable plants) decrease. Natural mortality increases, and natality decreases because of insufficient food. The plants "feedback" to cause a new, lower level of the animal population. Plants and ungulate populations oscillate with decreasing amplitude over time as dynamic equilibrium is achieved. Profound vegetation changes usually occur.

We believe our studies describe only a small part of the total picture of mountain goat/vegetation relationships in Olympic NP. Recent studies demonstrate that ungulates alter nitrogen cycles and soil formation processes. Moreover, vegetative changes wrought by one herbivore may influence the feeding behavior of other herbivores (such as the link between bison and prairie dogs). Given the relationship between site productivity and the degree of interspecific plant competition in Olympic subalpine vegetation, mountain goats are likely to have a far greater influence on individual plants, communities, and ecosystem processes than we have demonstrated here.

Status Report

Olympic staff are completing the Draft Environmental Impact Statement on mountain goat management (scheduled for release in early 1994). Once the EIS is released, a period of public comment will take place and a course of action will be selected. This may prove a significant test of NPS natural areas exotic species management policies.

Schreiner is a Research Biologist at Olympic NP Field Station; Woodward is with the U/WA CPSU, National Biological Survey.

Suggested Reading

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In the 7-year interval between 1981 and 1988, the Klahhane Ridge goat population was reduced by more than 80%. The entire wallow and its outwash have more plant cover, primarily Idaho fescue *(estuca idahoensis)* and yarrow *(Achillea millefolium)*, by 1988. The lower right wallow margin has grown-in considerably, but the steep undercut edges of the upper wallow have continued to erode further back despite establishment of Idaho fescue.

(PHOTO BY J. BURGER, OCTOBER 20, 1988)

Prescribed Fire: Current Status and Future Directions

By David J. Parsons
Research Scientist
Sequoia and Kings Canyon NPs

Sequoia and Kings Canyon NPs have long been recognized as national leaders in fire management and fire related research. Yet as these programs have matured, new questions and challenges have arisen. If these parks are to remain among the leaders in fire management, everything from program objectives to our understanding of fire effects and how such information influences programmatic decisions must be periodically reevaluated. Specifically, we must improve our understanding of the long-term, cumulative effects of varying fire regimes and management activities on park ecosystems. As our understanding of ecosystem processes and interactions improves, program objectives must be revised as appropriate.

In an effort to facilitate such a review, a prescribed fire workshop was held in the parks in January 1993. Thirty individuals representing park and regional office staff, the CPSU at U/CA Davis, Yosemite NP scientists and managers, the Boise Interagency Fire Center, the USFS, and university researchers participated in this 3-day review.

Workshop objectives were to assess the current status of the prescribed fire management and fire effects research programs; review the existing information base, and determine if (and how) this information and subsequent recommendations have been applied by management; identify management and research concerns and needs, and develop strategies for acquiring and applying new information.

Basically, we asked where we are with the program, how we got where we are, where we want to go, and how to get there. Emphasis was given to identifying data needs and applications and overcoming perceived constraints. The format made for informal, open discussion around general agenda items. The timing was particularly appropriate in that the political and advocacy group pressures that often have driven the program have been relatively quiet in recent years. A growing number of questions from park staff regarding program objectives and accomplishments assured a receptive audience and active participation.

Examples of the issues included: (1) the tendency to emphasize fire behavior rather than ecological objectives as the basis for setting prescriptions and evaluating "success"; (2) the need to articulate more clearly the program goals (what do we really mean when we say "reduce fuels" and "restore fire as a natural process"?); (3) identification of the constraints (funding, air quality, state and regional preparedness planning) that keep more acreage from being burned; (4) whether the current rate of burning is sufficient to make a difference, and (5) ways to improve our understanding of historic fire regimes and consequent fire effects and to improve feedback of such information to management.

Major conclusions reached included the following:

• In an effort to define more clearly an overall goal for the prescribed fire program it was agreed that the traditional emphasis on restoring fire as a "process" should be expanded to include recognition of the importance of the effects of that fire on forest structure. The goal of the overall program thus was reworded to read **"To restore and perpetuate the fire regime and the vegetation structure (or range of structural variability) that would have existed today had Europeans not come on the scene."** Improved understanding of the relationships between fire regime and vegetation structure will be required before specific structural objectives can be articulated.

• Burning rates in the mixed conifer forest zone need to be accelerated if anything even approaching natural fire regimes are to be restored. Yet, since it was felt that more damage is generally done by not burning than by burning without fully understanding all of the possible effects, lack of information should not be used as an excuse not to burn.

• If constraints to burning more acreage cannot be overcome, serious consideration must be given to identifying areas where natural fire frequencies can be maintained while managing others under either a fire suppression scenario or through application of other hands-on manipulations.

• Increased emphasis needs to be given to second and third burns in the mixed conifer forest zone. Under current conditions initial burns often create more fuels than existed prior to the fire. Similarly, emphasis needs to be given to getting away from the traditional burning of defined blocks under relatively uniform conditions. Use of larger, variable intensity fires set from point ignitions (rather than strip headfires) needs to be encouraged.

• Preparation time spent clearing fuels from around the base of trees in non-frontcountry sequoia groves presents a major time constraint and greatly limits the acreage that can be burned. It was agreed that additional effort should be given to studying the effects of past fuel manipulation practices in the sequoia groves. In addition, if increased sequoia regeneration and recruitment is desired, consideration must be given to finding ways to encourage occasional "hot spots" that punch holes in the canopy during prescribed burns.

• The current fire effects monitoring program does not provide sufficient levels of understanding on cause and effect relationships to permit statistically valid analysis of program effects (such as what frequencies and intensities of fire result in what types of forest structures?). The monitoring program must be supplemented with research studies to understand fully the relationships between fire behavior and effects.

• Smoke and related air quality issues have the potential to seriously restrict future burning activities (and have done so already in Yosemite). Increased emphasis needs to be given to monitoring smoke during different burning conditions and to understanding the effects of smoke on ecosystem properties and human health. Improved communication with local air quality districts also is essential.

• The lack of a base funded long-term research program on fire effects continues to plague program advancement. Critical questions regarding the historical range of fire frequency, intensity, season, and size for different vegetation types, and the effects of varying fire characteristics on vegetation structure, mortality, seedling recruitment and survival, etc., must be answered before we can make sure that program objectives are both reasonable and attainable. Research will be critical to defining the range of forest characteristics that we are trying to achieve as well as establishing criteria for evaluating success. Long-term studies of the effects of different burning patterns will require a base funded commitment to support rotational plots burned under different frequencies and intensities. Support also is needed to fully develop, validate, and implement fire spread and forest dynamics models that will permit managers to test the consequences of various management decisions.

In retrospect, this workshop provided a critical opportunity to reflect on past accomplishments and discuss future directions and needs for the parks' fire management and research programs. Many of the policies and practices that have been ingrained in our system were found to be lacking in the face of modern realities. Improved understanding of the interdependence of fire, climate, and vegetation, together with appreciation for the importance of the spatial and temporal variability of fire characteristics and ecosystem response, has forced recognition of the importance of trying new ideas and techniques. The lessons we learned from the 1963 Leopold report, while still of value, must be updated to reflect a new understanding of ecosystem dynamics. The need for improved understanding of disturbance processes and their effect on ecosystem properties could not be clearer.

Book Review

If the spate of new books and articles being spawned by the budding "sciences of complexity" is any indication, a whole new world paradigm is a-borning. The National Park System, and the Service which exercises collective stewardship over it, eventually will be caught up in any new paradigm that emerges, hence the following "review of reviews." The take-off point for each of the books is "complexity," and together they span much of the human condition—from ecology (with strong overtones of philosophy and religion) to "management" (our attempts to cope with the powers our tools have given us).

A new paradigm is one that affects our whole internal picture of reality. It involves general principles whose understanding and acceptance affect the ways we see and deal with our world and ourselves. At the same time, this particular paradigm—the sciences of complexity—has given rise to writings that question the heretofore largely unquestioned applicability of general principles in all instances—across the board.

Three books, all of which can be read as sequels to the book reviewed in the Summer 1993 issue of *Park Science*, (*Complexity: Life at the Edge of Chaos* by Roger Lewin), are:

Beginning Again: People and Nature in the New Millennium, by David Ehrenfeld, Oxford University Press, NY, 1993. 194 pp. $22.00 (ISBN 0-19-507812-8 cloth);

Leadership and the New Science, by Margaret J. Wheatley, Berrett-Koehler Publishers, Inc., San Francisco 1993. $22.95 (ISBN 1-881052-01-X);

Origins of Order: Self Organization and Selection in Evolution, by Stuart A. Kauffman, In Press, Oxford University.

All three are available in forms more accessible to the general public in the following manner:

Beginning Again as a review by Bryan G. Norton, School of Public Policy, Georgia Institute of Technology, Atlanta 30332, appearing in the January 1994 issue of *BioScience* (pp. 37-9);

Leadership and the New Science as a review by Susan Mokelke in *Timeline*, (pp.4-7), published bi-monthly by the Foundation for Global Community, 222 High St. Palo Alto, CA 94301-1097; and

Origins of Order as an article by the author himself, appearing first in *IS Journal #12*, the bi-yearly publication of International Synergy Institute, a global network of vanguard artists, scientists and activists, and appearing next in *Annals of Earth*, Vol. XI No. 3, 1993, pp 19-26.

To begin with the toughest, but still accessible to the layperson, Kauffman's article describes the evidence for the complexity scientists' claim that complex adaptive systems "achieve in a law-like way, the edge of chaos." This "edge of chaos" is described by Kauffman as "the phase transition zone" between two broad regimes that are "chaotic and ordered." It is in the narrow third complex regime—poised at the boundary of chaos—that Kauffman detects "order for free."

Kauffman leads the reader painstakingly through the complex pathway of how spontaneously ordered features of computer simulations parallel a host of ordered features seen in the ontogeny of mouse, human, bracken, fern, fly, bird. A "cell type," he explains, becomes a stable recurrent pattern of gene expression, or to use mathematical jargon, an "attractor"—like a whirlpool—a system toward which all the possible patterns of gene activities tend to flow and remain. Eventually he arrives at the following paragraph:

"Bacteria, yeast, ferns, and humans, members of different phyla, have no common ancestor for the past 600 million years or more. Has selection struggled for 600 million years to achieve a square root relation between genomic complexity and number of cell types? Or is this order for free so deeply bound into the roots of biological organization that selection cannot avoid this order? But if the latter, then selection is not the sole source of order in biology. Then Darwinism must be extended to embrace self-organization and selection."

Kauffman's articles (about his book) extrapolate complexity theory to such societal phenomena as economics. He posits the notion that complexity theory accounts for "why economics has had a difficult time building a theory of the evolution of technolgical webs."

Here, Kauffman may be illustrating what Ehrenfeld, in *Beginning Again*, warns against—the wholesale extrapolations of cherished "general principles." According to Norton, Ehrenfeld suggests that while physics emphasizes general laws that facilitate predictions and centralized control, biology is inherently a science of the **particular**. In Ehrenfeld's Part 1, "Taking Bearings," he explores aspects of the idea of **place**, the local and particular wisdom about, and commitment to, a home in the natural world. The word "chaos" again appears, often. "It is possible to steer through the chaos of modern life in a deteriorating environment, Ehrenfeld believes, if we follow the secret of all navigation: "the secret...is in paying attention to the fixed landmarks, both celestial and earthly" (p. viii from the book).

The celestial landmarks are described by Norton as "the gems of religious wisdom, introduced on nearly every page." The earthly landmarks (which are of intense interest to National Park System managers) represent the particular knowledge of particular places—the understanding, gained by ecologists and other sharp observers, of the particularities of life in diverse systems and landscapes. Ehrenfeld calls them "the innumerable examples of how to live and endure in the kaleidoscopic environment of our earthly and only home."

Thus, Ehrenfeld enjoins both ecology and religion as partners in the search for a new beginning.

Norton terms Ehrenfeld's book an embodiment of "religion in the best sense--an attitude of respect for cultural wisdom that emerges over many generations—without dogma—simply a search for wisdom as opposed to information, expertise, and technique.

With direct application to the National Park Service, Ehrenfeld states: "Places can be destroyed, that is, they can have their nature and meaning irrevocably changed and their connection with the past severed." And then he states (on p. 33) what Norton calls "the central insight of this insightful book":

"Conservation has to start at home, where we know, or ought to know, the problems, and where we are most likely to understand the opportunities and limitations of our solutions."

But managers do not escape with only guideposts. Ehrenfeld devotes much of his book (again according to Norton) to "the explosion of the managerial class, which he indicts as "the most destructive force of modern society." Norton quotes Ehrenfeld thusly:

"Overmanagement is a by-product of an exploitative age in which the massive extraction and processing of natural resources have been accompanied by the release of huge amounts of surplus wealth." He uses universities as an example of management run amok. He decries these large new "sources of unregulated cash" where a positive feedback loop emerges: the need to control funds, leading to more administrative tasks, even as more administrators choke the system and reduce the productivity of educators who are more and more frozen out of control of their own fates.

For another view of management, Wheatley's *Leadership and the New Science* offers hope that managers of the future will do their jobs within the new paradigm—one

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Book Review

The Visitor's Guide to the Birds of the Eastern National Parks: United States and Canada (1992; $15.95 U.S., $20.95 Canada) and **The Visitor's Guide to the Birds of the Rocky Mountain National Parks: United States and Canada** (1993; $15.95 U.S., $19.95 Canada), by Roland H. Wauer. John Muir Publications, Santa Fe, NM.

Those who know Ro Wauer will not be surprised to learn that he hasn't slowed down since retiring from the Park Service. Among other projects—such as serving on the National Academy of Sciences committee that produced the report, *Science in the National Parks*—Ro is writing a series of four books on birds in the national parks. Two of these have been published and the third—on the parks of central North America—is in press. This year he is researching and visiting parks along the west coast up to Alaska.

The series is the idea of Robert Cahn, noted conservation writer with a special interest in national parks. With his "trailer slave" (wife Betty), Ro has visited all the parks he writes about, adding this up-to-date acquaintance to knowledge gained and notes taken over his 32-year career with NPS. (Betty, not an avid birder, has enjoyed these trips more since taking up videography.)

The books are introductions to both birding and national parks. For each park, they describe the most common and obvious birds, their behavior, and plant community associations; park environments; and park facilities, services and publications. They also summerize the bird life as presented on the park checklist. With this format, readers can compare parks easily. Ro apparently assumed that readers would turn to selected park accounts and therefore wrote each account to stand alone. This results in descriptions of many species being repeated several times throughout the book. Ro's birding skills and close, precise observation habits are everywhere evident.

Because the books are written for beginning birders, advanced birders will be disappointed by the lack of discussion of the less common species. However, every reader will benefit from the advice on good birding areas and will find many bits of intriguing bird behavior. I was surprised to learn, for instance, that red-tailed hawks sometimes stalk their prey on the ground. Conservation messages, especially on neotropical migrants, are sprinkled throughout. The illustrations include maps of park locations and excellent bird drawings and color photos of park environments. A single summary checklist of all birds in the parks described, a list of plant names, and a bibliography end each book.

The books will be sold in many parks and will be useful additions to park libraries, for both staff and visitors. The central North America book should be out in 1994 and the west coast book in 1995.

Napier Shelton
NPS Washington Office

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that abandons the world of predicatability that Newton and Descartes envisioned in favor of a world of potentials and probabilities.

Wheatley is a Harvard-educated organizational consultant who, while trying to address the growing problem of organizational dysfunction, became obsessed with the new sciences of complexity and chaos. Haunted by such questions as "Why does change, which we are supposed to be managing, keep drowning us?," she plunged into a journey of discovery and arrived at her premise:

"I believe that we have only just begun the process of discovering and inventing the new organizational forms that will inhabit the 21st century. To be responsible inventors and discoverers, though, we need the courage to let go of the old world, to relinquish most of what we have cherished, to abandon our interpretations about what does and doesn't work. As Einstein is often quoted as saying, 'No problem can be solved from the same consciousness that created it.' We must learn to see the world anew."

It would seem that Wheatley has gone directly from a layperson's description of new sciences to the management implications they present for dealing with self-organizing systems. Change, stability, and renewal are hallmarks of a self-organizing system, and Wheatley defines the key to such systems (self-reference) this way:

"In response to environmental disturbances that signal the need for change, the system changes in such a way that it remains consistent with itself in that environment." She sees this as an optimistic lesson for despairing humans. Freedom and order are partners in the new paradigm...the more freedom in self-organization, the more order.

And further good news is the new insight that "under certain conditions, when the system is far from equilibrium [at the edge of chaos], creative individuals can have an enormous impact." As she notes, "It is not the law of large numbers, of favorable averages, that creates change, but the presence of a lone fluctuation [the butterfly wing effect] that gets amplified by the system." (*See Editorial, page 2 of this issue, for additional thoughts—Ed.*)

Information, Wheatley concludes, is the creative energy of the universe. Certainly this emerging paradigm suggests it. It was back in the '20s and '30s that astronomer Sir James Jeans observed: "The universe begins to look more like a great thought than a great machine."

Mokelke calls *Leadership and the New Science* an inspiring book, with much to offer any individual or organization walking the edge of chaos on the road to a higher order of being," and offers this quote from Wheatley as a concluding example:

"To live in a quantum world, to weave here and there with ease and grace, we will need to change what we do. We will need to stop describing **tasks** and instead facilitiate **process**. We will need to become savvy about how to nurture growing, evolving things. All of us will need better skills in listening, communicating, and facilitating groups, because these are the talents that build strong relationships. It is well knwon that the era of the rugged individual has been replaced by the era of the team player. But this is only the beginning. The quantum world has demolished the concept of the unconnected individual. More and more relationships are in store for us, out there in the vast web of universal connections."

Jean Matthews
Editor, Park Science

Latest Research at El Malpais Reveals Dating Errors

By A. William Laughlin

El Malpais National Monument was created to preserve some of the youngest and most spectacular volcanic rocks within the continental United States. These cinder cones and lava flows are part of the Zuni-Bandera volcanic field which in turn is just one of several volcanic fields that form a northeast trending alignment that extends across Arizona and New Mexico. Geologists refer to this alignment as the Jemez lineament. Although geologists have long known that the volcanoes and lava flows of the Zuni-Bandera volcanic field are very young, it has only been within the past 20 years that serious attempts have been made to determine the age of this volcanic activity. In the mid 1970s, we obtained potassium-argon dates on some of the older lava flows from the Zuni-Bandera volcanic field. These dates suggested that the older flows are about 1.4 millon years (Ma) old.

In the late 1980s and early 90s, a group of researchers from Los Alamos National Laboratory, the University of Arizona, and New Mexico Institute of Mining and Technology obtained an additional dozen potassium-argon and argon-argon dates from the volcanic field. The results of our second study indicated that our prior dates of about 1.4 Ma were in error (anomalously old). Our new results (Laughlin et al., 1993) indicated that there were three major pulses of volcanic activity within the Zuni-Bandera volcanic field. The first of these, which occurred about 700 thousand years ago (700 ka), produced basalt flows south and west of the Monument. A second pulse, which produced flows in the western part of the Monument, in the Chain of Craters area, took place between 150 and 110 ka. The third and youngest pulse of volcanic activity produced the spectacular Bandera and McCartys flows as well as the flows from the Lost Woman, Twin Craters, and Paxton Springs volcanoes. In this second study, we were unable to date these youngest flows.

In late 1992, a third geochronological study of the volcanic rocks of the Zuni-Bandera volcanic field and El Malpais National Monument was begun by researchers from Los Alamos National Laboratory, New Mexico Institute of Mining and Technology, and the New Mexico Bureau of Mines and Mineral Resources working with NPS staff. The major goal of this third study was to date the youngest volcanic rocks of El Malpais NM not only to aid in understanding the volcanic history of the area but also to provide a test area for calibrating newly developed dating techniques. To accomplish this goal, four different dating methods have been applied to these lava flows and volcanoes: argon-argon, radiocarbon, helium-3 surface dating, and uranium-series dating. At least two different methods have been applied to three different flows: the Bluewater flow (uranium-series and helium-3), the Bandera flow (radiocarbon, helium-3, and argon-argon) and the McCartys flow (radiocarbon and helium-3). Results on each of these flows are discussed below.

The Bluewater flow, which is probably the oldest flow of the third pulse, is exposed in the valley west of the town of Grants and outside the Monument. Prior to our most recent work, we had obtained two potassium-argon dates of 5.69 and 2.23 Ma on this flow. These dates were clearly anomalously old because of "excess" argon incorporated in the flow during crystallization. Two different samples of the surface of the Bluewater flow were collected for helium-3 dating. These samples yielded an average age of 57 +/- 6 ka; a third sample of the flow was dated by the uranium-series method, yielding an age of 79+40/-30 ka. The ages obtained by the two different methods agree within experimental error.

The Bandera flows were erupted from Bandera Crater, which lies within El Malpais NM about 40 km southwest of Grants, New Mexico. With the assistance of the NPS, a backhoe was used to excavate trenches through scoria erupted from the volcano. Two samples of charcoal for radiocarbon dating were collected from the soil immediately below the scoria. This charcoal probably represents roots burned from the heat of the scoria eruption. These samples gave ages of 10,050-10,070 and 10,990 calibrated years before present (B.P.). We believe that the older age is more likely to be correct. Three samples of the Bandera flow were dated using the helium-3 method giving ages of 11,000+/- 1,100, 10,000+/- 1,800, 12,500+/- 1,400 years. We consider the agreement between these methods to be exceptionally good. Work is now in progress on the argon-argon dating.

The McCartys flow, the youngest flow within the Monument, was also dated by both the radiocarbon and helium-3 methods. A site was found on the eastern edge of McCartys flow where stream erosion had cut beneath the flow. Two charcoal samples, representing burnt plant roots, were collected for radiocarbon dating from beneath the flow.

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The youngest pulse of volcanic activity at El Malpais National Monument about 3,000 years ago produced the McCarty flow, shown here overlying the approximately 80,000 year old Laguna flow.

El Malpais continued from page 29

These two samples gave an average age of 2,987+/- 92 calibrated years B.P. Two samples of the surface of McCartys flow were dated by the helium-3 method. These samples gave ages of 2,500+/- 1,100 and 2,400+/- 600 years. Again we consider the agreement between methods to be excellent.

The results of our third geochronological study were presented at a geochronology field conference held in Grants, New Mexico in April, 1993. This conference was hosted by Los Alamos National Laboratory, New Mexico Bureau of Mines and Mineral Resources, New Mexico Institute of Mining and Technology, and the NPS. In attendance were 55 geochronologists and geomorphologists from the U. S. and Canada. Considerable interest was expressed by the participants in developing El Malpais NM as a test area for new dating techniques. A large number of samples were collected during the conference for cosmogenic carbon, chlorine-36, and thermolumnescence dating and paleomagnetic studies. Results of these studies will be reported to the NPS on an annual basis.

Laughlin is with the Earth and Environmental Sciences Division, Los Alamos National Laboratory, Los Alamos, New Mexico 87545.

Bandera Crater (left center, by the highway) can be seen here together with several other cinder cones that lie within El Malpais National Monument.

CPSU Hosts 2nd Biennial Conference on Colorado Plateau Research

The Second Biennial Conference on Colorado Plateau Research was hosted by the Cooperative Park Studies Unit at Northern Arizona University (NAU), Flagstaff, Oct. 25-28, 1993. Patsy B. Reed, Interim President of NAU, introduced by Unit Leader Charles van Riper III, expressed pleasure at the university's opportunity to participate with the National Biological Survey (NBS) in gathering and disseminating biological research information.

Bruce Kilgore, NPS Western Region Chief Scientist, presented the NPS Director's Natural Resources Award to Henry O. Hooper, NAU's Vice-president for Academic Affairs, for his support of NPS resource protection issues and CPSU operations on the NAU campus.

Ray Stendell, Director of the National Ecology Research Laboratory (NERC) in Fort Collins, CO, shared information on the organizational structure and function of the new NBS and indicated that the CPSU, serving as a Research Station under NERC supervision, will continue to focus on research for the Colorado Plateau ecosystem.

Formal sessions opened with a workshop on the Endangered Species Act, followed by a session discussing the prototype I&M program developed for Montezuma Castle National Monument. The 167 registrants sampled 68 presentations in 8 paper sessions and two poster sessions. Papers covered topics in the fields of endangered and declining species, physical resources, animal and plant ecology, and cultural resources. A workshop on Global Positioning Systems (GPS) closed the conference. The conference program abstracts and author identification encouraged future information exchange among researchers.

Representatives from 7 agencies, 13 universities and colleges, and half a dozen other organizations took part in this truly interactive conference. Proceedings of the first such conference had just been published and were available to attendees. A proceedings from the second conference is due from the printer shortly.

Connie C. Cole
Publications Editor
NAU Cooperative Park Studies Unit

Cooperative Efforts Improve Forest Health at Coulee Dam

By Karen Taylor-Goodrich

Just what is "forest health"?

Recognizing that forest types vary considerably depending on which biogeographic province they're in, generally, a healthy forest is resilient to change, is biologically diverse, provides sustained habitat for fish and wildlife, and meets long-term resource management objectives.

A forest can become unhealthy when its natural dynamics are interrupted, challenged, or otherwise subjected to natural and/or human-caused agents that affect "normal" forest evolution. Agents such as fire (or lack of it), insects, diseases, site degradation, weather extremes, "catastrophic" events, air and water pollution, and improper forest management practices, all can contribute to making a forest unhealthy.

Unhealthy forests tend to be even-aged and overstocked stands with little resistance or resilience to pests.

Although forest pest infestations are considered natural processes, forests in developed areas also must be managed with visitor use in mind. At Coulee Dam National Recreation Area (CODA) the forests in our 26 developed visitor use areas pose unique management challenges. Decades of fire suppression, multiple years of drought, threats from poor forest management practices nearby, and other human caused activities have deteriorated the quality of the ponderosa pine (*Pinus ponderosa*) forests in the area.

Given the linear nature of the recreation area (Lake Roosevelt is 150 miles long with a 660-mile shoreline), and its proximity to other federal, state, tribal, and privately managed forests, we recognize the importance of managing forest vegetation in our developed sites in a way that enhances surrounding resources as well. The sustainability of forests in these areas of high recreational value is in question, and we realize that we may face major forest losses in our campgrounds if we do not act soon.

NPS staff are addressing forest health issues on Lake Roosevelt in cooperation with other resource agencies. We have utilized the expertise of Forest Service entomologists and pathologists in identifying the types and causes of insects and diseases taking over our forests. (This may sound melodramatic; forest pests are common and natural in forest ecosystems, however it's the degree of infestation that is of concern here.)

The Forest Service also has provided silviculturists to train NPS resource management and maintenance staff in the evaluation of local forest conditions. We are in our third year of funding for forest insect and disease management projects through the USFS sponsored Forest Pest Management Program. In addition to Forest Service staff, we have contacted resource professionals from other NPS areas, outside agencies, and universities to discuss the latest developments on managing forest insects and diseases in developed areas.

The first step was to recognize and document the extent of our forest health problems. We knew we had lost hundreds of trees to a major outbreak of western pine beetle in one of our popular campgrounds, but we didn't have enough information to determine the condition of all our developed sites. We decided to address the problem systematically, and we have taken measures to determine the extent of active infestations, the potential for continued insect and disease problems, and what management options for treatment are available to us.

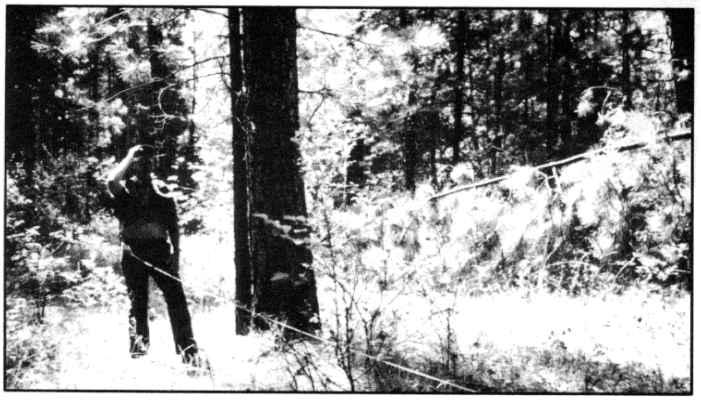
NPS resource management staff conducted an extensive Forest Insect and Disease Risk Assessment Survey of the 26 developed campgrounds at CODA in 1992. Based on basal area measurements (tree spacing), diameter at breast height (DBH), and other tree health indicators, preliminary survey results indicate the forests along Lake Roosevelt are extremely overstocked, stressed, even-age stands, with minimal regeneration occurring. This weakened condition has resulted in declining resistance and resilience to pest damage.

The survey has provided us with sufficient data to prioritize areas by level of health, allowing us to make more informed management decisions that may involve suppression and/or prevention activities. In order to keep infestations from spreading, and to address public safety concerns, active infestations receive the highest priority for treatment. Prescribed fire, and the removal of overstocked trees to an optimum level for growth will be used as secondary measures to improve overall forest vigor and resistance to pests.

Along with NPS efforts to improve forest health at CODA, most resource managers in the region are working to address the deteriorating condition of forests in the Inland Northwest, including Canada. Major forest insect and disease outbreaks are occurring throughout the area, and managers are working together to educate the public and their agencies on forest health issues. NPS staff at CODA are participating actively in regional forest health education efforts, and serving on task forces and committees to address these issues. Cooperative efforts to develop public information and educational materials involve press releases, posters, a brochure (completed), and a videotape (in the planning stage).

What we have learned will serve as a foundation for the long-term protection and preservation of significant ecological and recreational forest resources. Likewise, recognizing the importance of cooperative efforts to address both park and regionwide concerns can help us meet resource management objectives while developing mutually beneficial partnerships.

Taylor-Goodrich is the Resource Management Specialist at Coulee Dam NRA.



Left: Dean Gettinger performing height measurements.

Right: Ponderosa pines (*Pinus ponderosa*) in developed area (campground); infested and dying. Bark removed by woodpecker activity.

Meetings of Interest

1994

April 20-22 **Ecosystem Management of Natural Resources in the Intermountain West,** at Utah State University, Logan, UT; with 16 co-sponsors including NPS. Contact Dr. Gred Wagner, (801) 750-2555.

May 4-6 **1994 GEOLOGIC SOCIETY OF AMERICA, ROCKY MOUNTAIN SECTION MEETING,** Durango, CO; papers from a platform session on NPS Paleontological Research, chaired by Vincent L. Santucci, will be published in a symposium volume. Contact Santucci at (412) 766-6207.

May 16-18 **SECOND INTERNATIONAL CONFERENCE ON SCIENCE AND MANAGEMENT OF PROTECTED AREAS,** at Dalhousie U, Halifax, Nova Scotia; contact: Neil Munro, Parks Canada, Historic Properties, Upper Water St., Halifax, N.S., CANADA B3J 159; FAX (902) 426-7012.

June 7-10 **FIFTH INTERNATIONAL SYMPOSIUM ON SOCIETY AND RESOURCE MANAGEMENT,** CO/State/U, Fort Collins, CO. Michael J. Manfredo, program chair; contact Human Dimensions in Natural Resources Unit, CO/State/U, Fort Collins, CO 80523.

Aug. 28–Sept. 2 **6th ANNUAL INTERAGENCY WILDERNESS CONFERENCE,** tentatively scheduled for Santa Fe or Albuquerque, NM.

Oct. 22-26 **NATIONAL SYMPOSIUM ON URBAN WILDLIFE** at Seattle-Bellevue, WA Embassy Suites Hotel; a 2-day local workshop will precede the national focus on the needs of wildlife, advice for conservation, and measuring progress toward meeting the needs of both people and wildlife in metropolitan environments. Sponsored by the National Institute for Urban Wildlife; contact Dr. Lowell W. Adams, NIUW, 10921 Trotting Ridge Way, Columbia, MD 21044; (301) 596-3311.

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